electronics

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NOVEMBER · 1956

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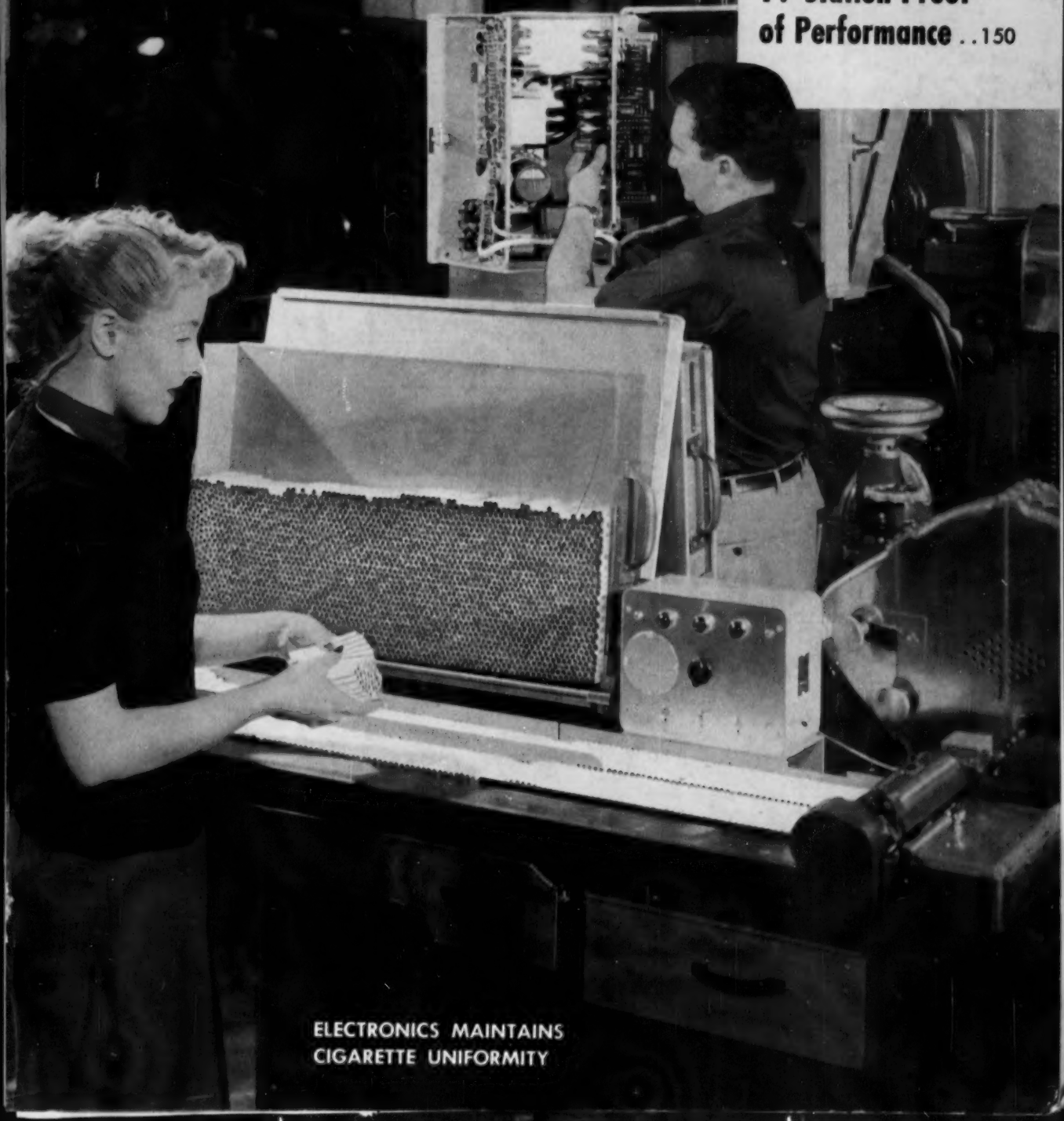


ELECTRONICS MAINTAINS
CIGARETTE UNIFORMITY

LEADERS IN MINIATURIZATION FOR OVER TWENTY YEARS...

MINIATURIZED TRANSFORMER COMPONENTS FROM STOCK

Items below and 650 others in our catalog A.

HERMETIC SUB-MINIATURE AUDIO UNITS

These are the smallest hermetic audios made.

Dimensions . . . 1/2 x 11/16 x 29/32 . . . Weight.8 oz.

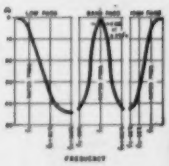
TYPICAL ITEMS

Type No.	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	DC in Pri MA	Response ±2 db (Cyc.)	Max. level dbm
H-30	Input to grid	TF1A10YY	50*	62,500	0	150-10,000	+13
H-31	Single plate to single grid, 3:1	TF1A15YY	10,000	90,000	0	300-10,000	+13
H-32	Single plate to line	TF1A13YY	10,000*	200	3	300-10,000	+13
H-33	Single plate to low impedance	TF1A13YY	30,000	50	1	300-10,000	+15
H-34	Single plate to low impedance	TF1A13YY	100,000	60	.5	300-10,000	+ 6
H-35	Reactor	TF1A20YY	100 Henries-0 DC, 50 Henries-1 Ma. DC, 4,400 ohms.				
H-36	Transistor interstage	TF1A15YY	25,000	1,000	.5	300-10,000	+10

*Can be used with higher source impedances, with corresponding reduction in frequency range and current

COMPACT HERMETIC AUDIO FILTERS

UTC standardized filters are for low pass, high pass, and band pass application in both interstage and line impedance designs. Thirty four stock values, others to order. Case 1-3/16 x 1-11/16 x 1-5/8—2-1/2 high . . . Weight 6-9 oz.

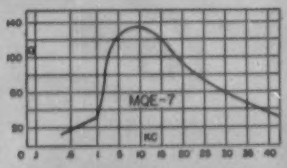


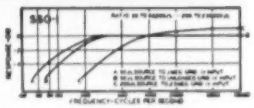
HERMETIC MINIATURE HI-Q TOROIDS

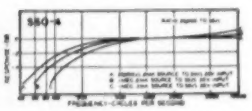
MQE units provide high Q, excellent stability and minimum hum pickup in a case only. 1/2 x 1-1/16 x 17/32 . . . weight 1.5 oz.

TYPICAL ITEMS

Type No.	Inductance	DC Max.
MQE-1	7 mhy.	135
MQE-3	20 mhy.	80
MQE-5	50 mhy.	50
MQE-7	100 mhy.	35
MQE-10	.4 hy.	17
MQE-12	.9 hy.	12
MQE-15	2.8 hy.	7.2







SUB-SUBOUNCER AUDIO UNITS

UTC Subouncer and sub-subouncer units provide exceptional efficiency and frequency range in miniature size. Constructional details assure maximum reliability. SSO units are 7/16 x 3/4 x 43/64 . . . Weigh 1/50 lb.

Type	Application	Level	Pri. Imp.	MA D.C. in Pri.	Sec. Imp.	Pri. Res.	Sec. Res
*SSO-1	Input	+ 4 V.U.	200 50	0	250,000 62,500	13.5	370
SSO-2	Interstage /3:1	+ 4 V.U.	10,000	0-.25	90,000	750	325
*SSO-3	Plate to Line	+20 V.U.	10,000 25,000	3 1.5	200 500	2600	3
SSO-4	Output	+20 V.U.	30,000	1.0	50	2875	4.
SSO-5	Reactor 50 HY at 1 mil. D.C. 4400 ohms D.C. Res.						
SSO-6	Output	+20 V.U.	100,000	.5	60	4700	3.
*SSO-7	Transistor Interstage	+10 V.U.	20,000 30,000	.5 .5	800 1,200	850	12

* Impedance ratio is fixed, 1250:1 for SSO-1,1:50 for SSO-3. Any impedance between the values shown may be employed.

OUNCER (WIDE RANGE) AUDIO UNITS

Standard for the industry for 15 yrs., these units provide 30-20,000 cycle response in a case 7/8 dia. x 1-3/16 high. Weight 1 oz.

TYPICAL ITEMS

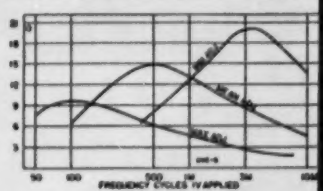
Type No.	Application	Pri. Imp	Sec. Imp
O-1	Mike, pickup or line to 1 grid	50, 200/250, 500/600	50,000
O-4	Single plate to 1 grid	15,000	60,000
O-7	Single plate to 2 grids, D.C. in Pri.	15,000	95,000
O-9	Single plate to line, D.C. in Pri.	15,000	50, 200/250, 500/600
O-10	Push pull plates to line	30,000 ohms plate to plate	50, 200/250, 500/600
O-12	Mixing and matching	50, 200/250	50, 200/250, 500/600
O-13	Reactor, 300 Hys.—no D.C.; 50 Hys.—3 MA. D.C., 6000 ohms		

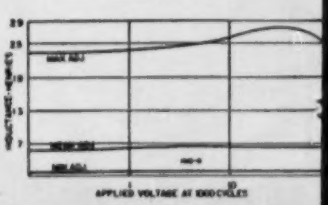
HERMETIC VARIABLE INDUCTORS

These inductors provide high Q from 50 - 10,000 cycles with exceptional stability. Wide inductance range (10 - 1) in an extremely compact case 25/32 x 1-1/8 x 1-3/16 . . . Weight 2 oz.

TYPICAL ITEMS

TYPE No.	Min. Hys.	Mean Hys.	Max. Hys.	DC Ma
HVC-1	.002	.006	.02	100
HVC-3	.011	.040	.11	40
HVC-5	.07	.25	.7	20
HVC-6	.2	.6	2	15
HVC-10	7.0	25	70	3.5
HVC-12	50	150	500	1.5





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ELECTRONICS MAINTAINS CIGARETTE UNIFORMITY—Rate of tobacco feed and density of tobacco rod are automatically controlled by machine designed by American Machine and Foundry Co. to produce uniform cigarettes (see page 144) ..... COVER

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SHOP

► **IN THIS ISSUE . . .** The punched card reader described on page 148 is currently being used by one of the authors, Vito Proscia, in an experimental investigation of azimuth accuracy obtained with search radars. Proscia, who is blind, programs statistical data into an IBM 602A computer using punch boards having braille markings.

Output is in the form of punch cards which he then "reads" by using the card reader.

Vito wishes he had a similar device to read technical articles and textbooks to him. He employs people with engineering backgrounds to read to him, but, like many employers these days, is constantly seeking new ones for replacements.

► **DEMPA CONFUSIN . . .** Back in August we announced the acquisition of a new (to us) phrase for manuscript, dempa gizitsu. Then we heard from readers.

Frank Inami of Livermore, California wrote in to say that he does not agree with the translation of dempa gizitsu as technical literature or manuscript.

"According to my new Concise Japanese-English Dictionary (1952) "dempa" means an electric wave and "gizitsu" is not listed. The closest word to it that I can find is "gijutsu" which means an art or technique. Therefore, a strict translation of "dempa gijutsu" would be electric wave techniques.

"A freer translation might give

electronics

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Member ABC and ABP

TALK

radio techniques, radar techniques, pulse techniques and others. Since there are myriads of homonyms in the Japanese language, one would have to see the Japanese characters in order to make a correct translation."

Next we heard from Roy K. Nishida, a service analyst with North American Aviation. He tells us that we have been misinformed about the phrase "dempa gizitsu". It is used as the name of a popular electronics magazine in Japan.

"Dempa" means electric wave. "Gizitsu" means technique or technology. The correct translation would be electric wave technology or translated loosely, transmission technique. I have used the magazine on several occasions for reference purposes.

I have just returned from nearly five years of writing articles and reports on the Japanese electronics industry for the U. S. A. F.

The correct word for manuscript is "shorui".

Our thanks go to both readers. The envelope that caused our confusion is reproduced here with its Roman letters, homonyms and script. It shows two spellings of the word "gizitsu", but neither matches the dictionary!

BILINGUAL envelope illustrates why we stubbed our linguistic toe; but we nevertheless do like to receive shorui from authors

▶**SHORUI** . . . Managing director Akio Morita of a Japanese company stopped in to say hello a few weeks ago. He confirms the fact that the word for manuscript is "shorui". He also tells us that the envelope that enclosed the portion of the technical material sent to us was used for convenience just as we often use second-hand envelopes to separate papers and drawings.

We were startled to find that he pays $120 a year to see ELECTRONICS quickly. Each month a copy is air mailed to him. It reaches Japan within 3 or 4 days after it has left our printer in Albany, New York. Other copies of our magazine go by sea mail and take about a month in transit. Morita's company, Tokyo Tsushin Kogyo, Ltd., spends $250 a month on foreign magazines but only ELECTRONICS goes by air mail. The copies are passed around to 120 graduate engineers of the 500 employees.

We noted a few more foreign phrases while lunching. In Japan, the superregenerative circuit is called "cho sai sei" but a superheterodyne is called a "super". Tape recorder is "terico".

Published monthly with an additional issue in June by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. **Executive Editorial and Advertising Offices: McGraw-Hill Building, 330 W. 42 St., New York 36, N. Y.** Longacre 4-3000. Publication Office, 99-129 North Broadway, Albany 1, N. Y. Donald C. McGraw, President; Paul Montgomery, Executive Vice-President; Joseph A. Gerardi, Executive Vice-President and Treasurer; Hugh J. Kelly, Executive Vice-President; John J. Cooke, Secretary; Nelson Bond, Executive Vice-President, Publications Division; Ralph B. Smith, Vice-President and Editorial Director; Joseph H. Allen, Vice-President and Director of Advertising Sales; J. E. Blackburn, Jr., Vice-President and Circulation Director.

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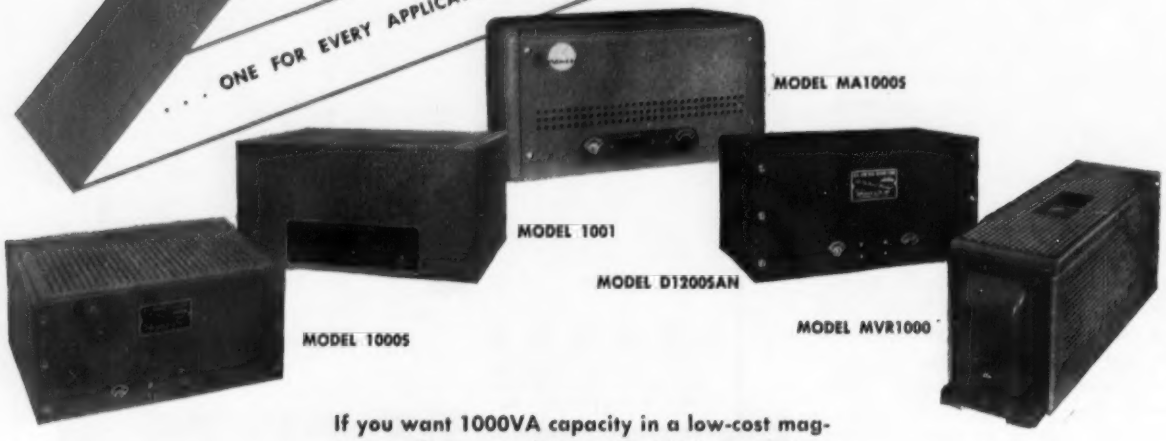

If you want 1000VA capacity in a low-cost magnetic voltage regulator with 0.5% regulation, choose the new, economical and compact MVR1000. If you need 1000VA but with 0.01% regulation, choose Model 1001. For *any* requirement, *any* application, Sorensen has exactly the right 1000VA unit . . . standard models meeting *special* requirements.

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PRECISION ELECTRICAL INSTRUMENTS

Want more information? Use post card on last page.

FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month	Previous Month	Year Ago
	Aug. '56	July '56	Aug. '56
Television sets, total	612,927	336,931	647,903
With UHF	90,419	41,803	105,673
Color sets	nr	nr	nr
Radio sets, total	990,845	566,697	947,634
With F-M	43	273	13,172
Auto sets	198,087	198,565	403,320

RECEIVER SALES

(Source: RETMA)	Aug. '56	July '56	Aug. '55
Television sets, units	566,158	405,310	586,577
Radio sets (except auto)	681,899	576,453	456,625

RECEIVING TUBE SALES

(Source: RETMA)	Aug. '56	July '56	Aug. '55
Receiv. tubes, total units	43,948,000	31,400,000	45,238,000
Receiv. tubes, value	$34,507,000	$24,781,000	$33,099,000
Picture tubes, total units	1,099,605	585,380	1,048,534
Picture tubes, value	$19,628,837	$10,861,634	$19,812,567

INDUSTRIAL TUBE SALES

(Source: NEMA)	Quarterly Figures: Latest Quarter	Previous Quarter	Year Ago
	1st '56	4th '55	1st '55
Vacuum	$8,754,054	$9,967,411	$8,784,478
Gas or vapor	$3,394,059	$3,251,621	$3,747,490
Magnetrons and velocity modulation tubes	$15,136,522	$13,726,323	$14,229,442
Gaps and T/R boxes	$1,455,558	$1,578,767	$1,434,683

MILITARY PROCUREMENT

(Source: Defense Dept.)	1st '56	4th '55	1st '55
Army	$40,490,000	$48,477,000	$2,833,000
Navy	$28,700,000	$20,378,000	$43,147,000
Air Force	$124,828,000	$131,938,000	$133,503,000
Total—Electronics	$194,018,000	$200,793,000	$179,483,000

BROADCAST STATIONS

(Source: FCC)	Latest Month	Previous Month	Year Ago
	Sept. '56	Aug. '56	Sept. '55
TV stations on air	507	507	473
TV stations CPs—not on air	113	113	108
TV stations—new requests	54	49	28
A-M stations on air	2,958	2,939	2,771
A-M stations CPs—not on air	106	112	113
A-M stations—new requests	276	268	219
F-M stations on air	527	525	538
F-M stations CPs—not on air	19	20	17
F-M stations—new requests	9	9	7

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Aug. '56	July '56	Aug. '55
Aeronautical	50,641	49,639	45,203
Marine	58,432	57,529	52,440
Police, fire, etc.	21,153	20,943	18,877
Industrial	31,146	30,776	25,189
Land transportation	9,141	9,027	7,804
Amateur	150,565	149,032	138,852
Citizens radio	19,997	19,253	13,189
Disaster	330	327	319
Experimental	730	722	652
Common carrier	2,412	2,356	1,988

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	July '56	June '56	July '55
Prod. workers, comm. equip.	383,100-p	387,200-r	355,600
Av. wkly. earnings, comm.	$73.30 -p	$74.59	$68.50
Av. wkly. earnings, radio	$72.65 -p	$72.40	$67.30
Av. wkly. hours, comm.	39.2 -p	40.1	38.7
Av. wkly. hours, radio	39.7 -p	40.0	38.8

SEMICONDUCTOR SALES ESTIMATES

	July '56	June '56	May '56*
Transistors, Units	885,000	1,131,000	898,000

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Sept. '56	Aug. '56	Sept. '55
Radio-tv & electronics	389.0	405.8	467.7
Radio broadcasters	484.9	510.2	537.2

p—provisional r—revised nr—not reported
*1955 not available

FIGURES OF THE YEAR

	FIGURES FOR FIRST EIGHT MONTHS 1956	1955	Percent Change	1955 Total
Television set production	4,365,060	4,820,991	— 9.4	7,756,521
Radio set production	8,216,707	8,707,477	— 5.6	14,894,695
Television set sales	3,839,718	4,171,139	— 7.9	7,421,084
Radio set sales (except auto)	4,649,454	3,189,608	+45.8	6,921,384
Receiving tube sales	303,004,000	300,080,000	+ 1.0	479,802,000
Cathode-ray tube sales	6,837,728	6,478,351	+ 5.5	10,874,234

Computers Readied for Election Results

Three major tv networks will feature computers as part of national sistor sales volume

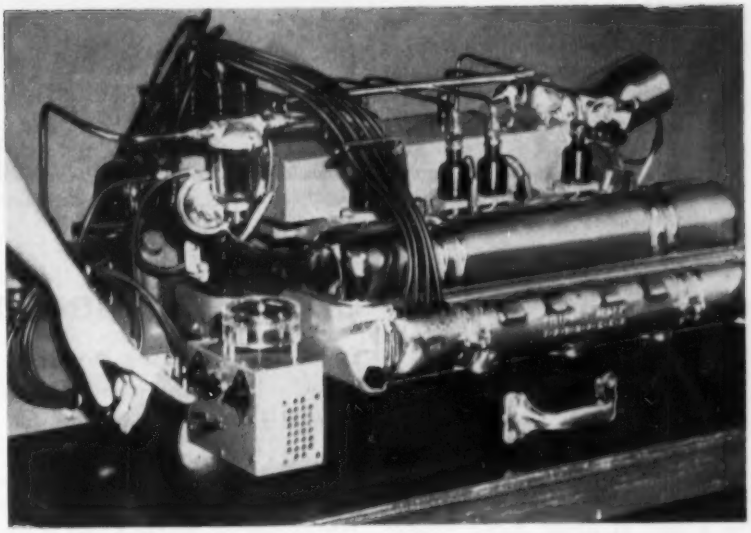
MULTIMILLION-DOLLAR array of electronic equipment will be put into use by ABC, CBS and NBC to predict the trends and result of the presidential election race.

► **Equipment Facilities** — Underwood Corp. will supply ABC with an electronic computer, the Elecom 125, which will type its own forecast every half hour on a special typewriter. The computer will be located at the new Underwood Data Processing Center in New York City, where three tv cameras will pick up the computed results.

Arrangements with IBM call for a bank of computers, sorters, printers and other equipment to be installed in an NBC studio in New York City. The computations will be displayed on a 50-foot bank of electronic tally boards to be provided by Teleregister Corp.

Election headlines at CBS election headquarters will be flashed periodically on an electronic bulletin board composed of running lights that are activated by a punched-tape typed on a special typewriter. On hand again will be Remington Rand's Univac.

► **Future Business**—The Los Angeles County Board of Supervisors is looking for an electronic or electromechanical device to tally votes. They invite manufacturers to submit development bids.



ELECTROJECTOR device developed by Bendix uses electronic modulator unit with 5 transistors and . . .

Controls Car Fuel Injector

Adoption by the auto industry could provide a big boost in transistor sales volume

ELECTRONIC fuel-injection system employing transistors developed by Bendix Aviation (ELECTRONICS, p 16, Oct. 1956) holds promise of opening a vast new market for transistors. If the system is widely adopted by the automobile industry, which is expected to produce about 6-million cars this year and 6.5 million in 1957, a potential market of 30-million transistors a year could materialize for the electronics industry. The system also utilizes six to eight thermistors.

► **Makers**—The new system, called Electrojector, is now ready to be adapted to engines of any car manufacturer. Among the auto makers that have seen the device are American Motors, Ford, Chrysler, Buick and Lincoln.

So far car manufacturers have not announced adoption of the device. Action may be forthcoming soon, especially as a result of Chevrolet's recent announcement that a mechanical, nonelectronic fuel injection system will be offered as optional equipment on its 1957 models. Chrysler Corp. has indicated that transistorized fuel injection will not be used on its 1957 models, but has not disclosed its plans for 1958 cars. It has been rumored that Ford may offer the transistorized system for use on

its 1957 models now on the market.

▶**Works**—The Bendix system consists of an electronic modulator, in a 4- by 5-inch box, utilizing 5 transistors made by the Red Bank transistor division of the company; a fuel-injection distributing commutator, fuel-injection breaking points and fuel-injection nozzles. The throttle body unit signals the modulator for proper enrichment necessary for acceleration and idling.

A thermistor in the water jacket of each cylinder senses the engine temperature and also acts as a signaling device for starting and warming up.

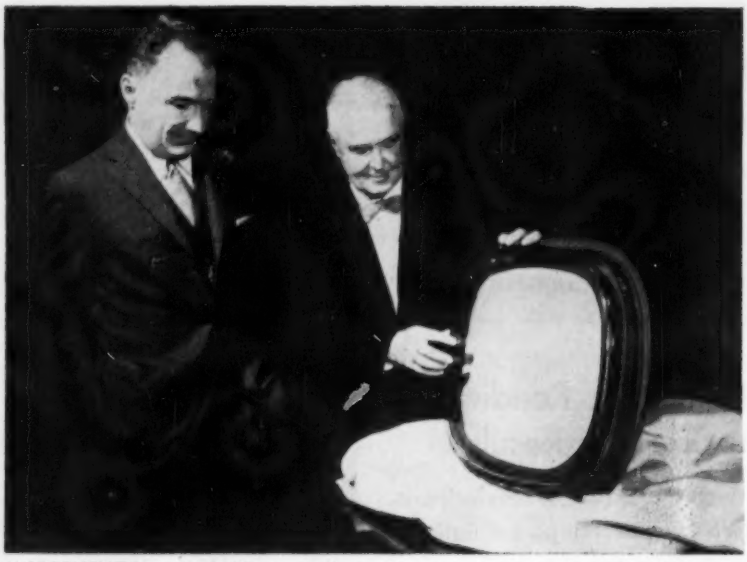
The modulator is actuated by power from the distributor-breaker unit. It receives signals from the various components, such as the throttle body and the intake manifold pressure sensor and passes them along to the fuel injectors. The injectors shoot tiny jets of gas into the intake ports of the engine's cylinders.

▶**Price**—Fuel injection has not been widely used in the auto industry mainly because of performance and costs. It has been used on race cars and sports cars, at a cost of about $500. Bendix has not indicated a cost for the transistorized system to motorists, but points out that the system, in mass production, can be reduced in price as has happened with other recent auto improvements.

RETMA Pegs Sales Volume At $9 Billion

VALUE of radios, televisions, phonographs, military and industrial equipment and components of the electronic industry totaled $5.5 billion in 1955, according to RETMA'S new edition of its electronics industry "Fact Book."

With distribution and maintenance costs and broadcasting revenues added, the industry's volume reaches $9.7 billion, nine times its size at the end of World War II. In 10 years this volume is expected to double.



AGREEMENT between DuMont and Chromatic, whose top officials examine Lawrence color tube above, . .

Speeds Single-Gun Color Sets

Lawrence tube to be mass produced and receiver design geared for production

PROGRAM aimed to get the Chromatic single-gun color tube and set into production within a year is under way at DuMont Laboratories. Preparatory work leading to mass production of the tube and color receivers is expected to be completed within a year. When production begins, the tube will be available to all set manufacturers.

▶**Firms** — DuMont becomes the third U. S. licensee of the Chromatic tube. Crosley and Thomas Electronics are the others but neither has gone into production of the tube. Crosley no longer has its picture tube plant and Thomas, which is now producing the shadow-mask tube, has no present plans for producing the Chromatron.

▶**Interests** — Behind the DuMont move is the fact that Paramount Pictures owns 25 percent of DuMont and 50 percent of Chromatic Labs. It is reported that DuMont will receive a minority interest in Chromatic for its efforts and Chromatic will receive royalty fees.

Considerations involved in the DuMont decision, according to president David Schultz, were that present cost of color receivers, color tubes and color servicing are too high for the mass market, that there appears no clear road to achieve the necessary cost reductions in the present color tube approach and that the Chromatic tube will make possible a receiver that can be sold and serviced at a profit and at a price to develop the necessary mass market.

▶**Present Status** — According to Chromatic, present laboratory receiver models have highlight brightnesses of around 60 foot lamberts as compared to 20 foot lamberts for color sets now on the market. The tube has a screen area of 250 sq inches and definition capabilities beyond that of present color standards with contrast ratios of 50 to 1, according to Chromatic. The lab sets have four or five more tubes than present black and white receivers.

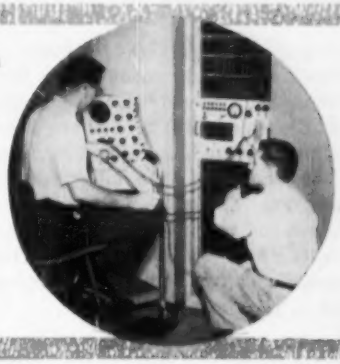
There have been no recent estimates of how much the single-gun tube might cost to produce. However, earlier announcements by Chromatic have indicated that fac-

(Continued on page 10)

With UDOFT circuitry drawings as background, computer systems engineers at Sylvania's Avionics Laboratory discuss design of an extremely high-speed magnetic core memory. From left: J. J. Wargo, F. M. Bosch, and John Terzian.

The right people with the right facilities produce the right solutions

New Sylvania Waltham Laboratories, devoted to advanced projects related to guided missiles and aviation electronics. The air-conditioned building has 120,000 square feet of floor space.



Computer development engineers E. L. Perry (left) and A. F. Gianino perform final test runs on engineering model of special-purpose large-scale digital computing system at the Waltham Laboratories.

UDOFT

—new electronic "brain" to train jet pilots

UDOFT—the first Universal Digital Operational Flight Trainer—will use a new electronic "brain" to simulate flight and combat conditions of a wide variety of jet aircraft for training pilots.

A Navy-sponsored project of Sylvania's Avionics Laboratory, the UDOFT system is centered around a new digital computer of great flexibility, speed, and accuracy which is being developed to take the place of numerous special-purpose analog computers currently being used in Operational Flight Trainers.

Highly advanced electronics projects of many kinds—each aimed at a practical, *producible* solution for a specific problem—are constantly being carried out by the scientists and engineers of Sylvania's Electronic Systems Division, of which the Avionics Laboratory is a vital part.

In all of Sylvania's Electronic Systems Division installations, the right people work with the right facilities, within a sound managerial environment. That is why they have produced right solutions to a variety of problems, and have made many important contributions in the fields of aviation electronics, guided missiles, countermeasures, communications, radar, computers, and control systems. Whether the problem is military or industrial, Sylvania's business is to come up with solutions that are producible.

Facilities of the Electronic Systems Division include its manufacturing plant and engineering laboratory at Buffalo, New York; the Avionics Laboratory, Missile Systems Laboratory, and Applied Research Laboratory at Waltham, Massachusetts; the Electronic Defense Laboratory, Microwave Tube Laboratory, and Microwave Physics Laboratory at Mountain View, California. All of these facilities are staffed with top-ranking scientists and engineers, backed with Sylvania's extensive resources in the electronics field.

SYLVANIA IS LOOKING FOR ENTERPRISING ENGINEERS

Sylvania has many opportunities in a wide range of defense projects. If you are not now engaged in defense work, you are invited to contact Edward W. Doty, Manager of Personnel, Electronic Systems Division, Sylvania Electric Products Inc., 100 First Avenue, Waltham 54, Mass.

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tory price of the tube would be approximately $85 on the first 200,000 units produced and about $50 when output reached 300,000 to 500,000 units. Price of a receiver incorporating the tube has been estimated at $340.

Split-Channel Action Means More Mobiles

FCC decision paves way for narrow channels at 152-162 mc, but sidesteps change in 25-50 mc

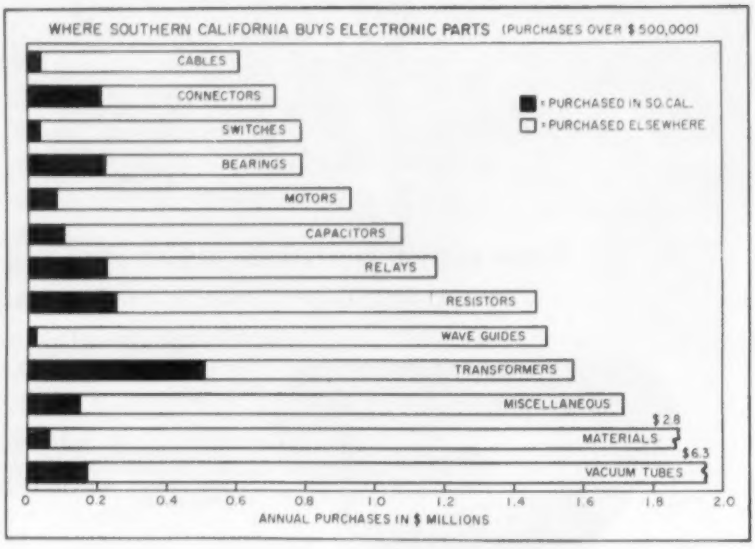
RELIEF may be in sight for users of mobile radio equipment in the frequency range between 152 and 162 mc. Technical standards have been adopted by the Federal Communications Commission to allow use of narrower channels and thus increase the potential number of operating stations. Overcrowded frequencies can expect some thinning out in the near future.

► **Who's Affected**—At the moment, no station or service is affected by adoption of the new technical standards. A series of proceedings will be initiated to determine how best to go about reassigning frequencies. There will be no blanket reallocation. However, police, fire and taxi radio — all hard-pressed — qualify for consideration.

Plans call for future use of frequencies seperated by 30 kc for stations operating in the same geographical area. Assignments to stations operating in adjacent areas can be safely cut to channel assignments only 15 kc apart. Present frequencies are 60 kc apart.

► **Problem** — Although split channels were considered for use in the whole span of vehicular radio frequencies, FCC shied away from applications in the 25-50 mc band. Conditions for many users here are bad and getting worse. Problems of international (long-range) interference and unknown factors in scatter transmission make split channels infeasible—unless individual users wish to narrow their own transmissions. In fact, FCC urged operators in this band to consider moving to higher frequencies.

West Coast Wants Parts Makers



Survey indicates areas for expansion by eastern and midwestern component firms

MANUFACTURERS of electronic components could improve their sales and service in Los Angeles and Orange counties in California if they established engineering or production facilities in the area, according to an electronic component survey made by the Los Angeles Chamber of Commerce.

A total of 146 electronics firms participated in the survey. They represent 51 percent of the 1955 factory billing of the industry in Southern California. These firms named the 28 components shown, accounting for a $22-million local market, as critical to the local industry.

► **Parts** — The firms surveyed named 85 eastern firms, manufacturing 23 component lines, that could improve their sales and service to the local industry by setting up branches in the area. Components most frequently mentioned are wire, resistors, capacitors, solid-state devices, miniature motors, precision switches, cores and bearings.

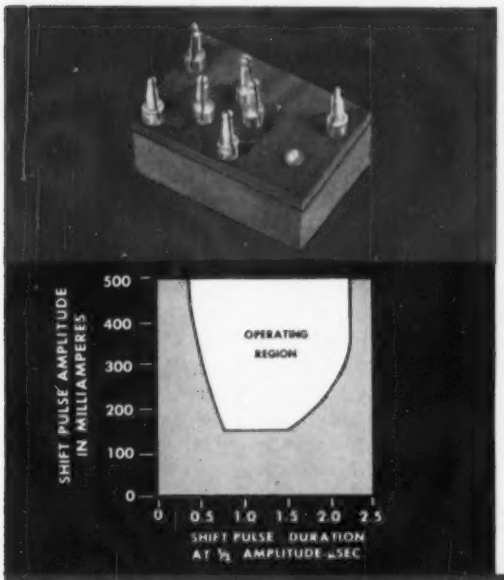
The percentage of components manufactured outside Southern California and utilized by the local industry ranges as high as 90 percent. Excluding the firms which manufacture their own components in a division or subsidiary outside the area, over half of Southern California's component requirements are purchased from eastern and midwestern sources.

► **Price**—Fifty-five percent of the firms participating in the survey purchase in the east rather than locally because of price. Price differential on the components ranges from 5 percent on a-c motors and compression terminals up to 100 to 200 percent on a-c solenoids. Components most frequently purchased in the east because at lower prices than presently manufactured local products are transformers, capacitors, motors, cable and connectors.

► **Need**—Rapid technical advances resulting from accelerated research programs and new environmental standards tend to make nonstandard componenets the rule rather than the exception, according to the study. Ninety-four percent of the companies indicated that closer engineering and design liaison between component vendors and end-equipment manufacturers are becoming increasingly more important. Eighty-seven per-

(Continued on p 12)

now . . . magnetic shift registers from SPRAGUE



operating frequency	0-200 kc
shift pulse	
Nominal Operating Current	300 ma
Voltage Drop Per Stage	6.5 volts
Duration (at half amplitude)	1.2 μsec
Rise Time	0.3 μsec
Fall Time	0.3 μsec
Peak Pulse Power	2 watt
input pulse	
Amplitude	10 ma
Duration	3 μsec
parallel output pulse	
Amplitude	15 volts
Ratio (Minimum)	10:1
Load Impedance (Minimum)	1500 ohms
diode	
Type	T-5 or equiv.

Now, from one reliable source, you can get a complete series of magnetic shift register assemblies . . . with read and write provisions . . . terminal wired and packaged to your special needs. *Plus* complete field engineering service for arriving at specifications and procuring registers that meet them.

Sprague's new registers are not only suitable for counters in computers and industrial controls, but for a wide variety of logical functions in "and", "or", and "not" circuits.

Five packages are standard, with others available if needed. The 71Z series have mounting ears, that simplify assembly of large arrays of bits in a single rack or frame. Series 70Z registers can be had in several terminal designs for mounting on etched wiring boards, or may be plugged into each other for permanent system flexibility. All 71Z units are mounted in hermetically sealed, corrosion-resistant metal cases with glass-to-metal solder-seal terminals for complete humidity resistance. Type 70Z units are embedded in resin for less demanding environments. Semi-conductor diodes may be externally connected between terminals, or integrally packaged in each assembly.

All Sprague shift register cores are subjected to rigid tests, assuring reliable operation in the final circuit use. Finished assemblies are 100% pulse performance tested to assure conformity with engineering specifications. Specifications for a typical 200 kc shift register, are shown above.

Complete specifications for all standard registers are in Engineering Bulletins 550C and 551, available on request to the Technical Literature Section, Sprague Electric Co., 35 Marshall St., North Adams, Mass.

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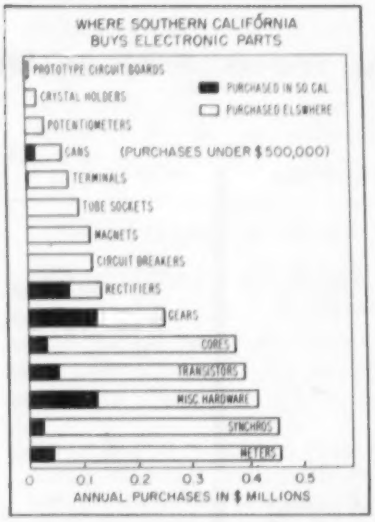


cent of the firms indicate that basic or off-the-shelf components are not meeting the present quality and environmental standards of systems work.

U.S. Starts Nuclear Warning System

Low-cost electronic system detects and protects against atomic attack on underground posts

NUCLEAR bombardment defense system to protect important underground military and civilian installations in the event of a surprise attack has been developed by the Army Signal Corps. Known as the Radiological Defense Warning System, it is already at work at one large military headquarters.

Installation is planned at important U. S. Air Force bases, also by Civil Defense authorities at strategic locations throughout the country. It could be used to protect key industrial plants and warehouses.

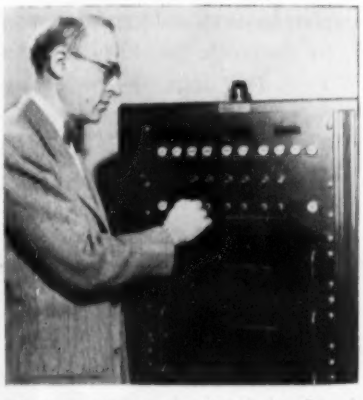
▶ **Value**—Cost of the system is low.

Engineer's estimate the total electronic portion, for example, will cost about $500 when in full production.

It detects any atomic or hydrogen bomb explosion endangering an installation, tripping relays that instantly sound warning horns, close blast doors, turn off gas lines, start radiologically filtered ventilation systems and trigger a series of other protective measures.

▶ **Detectors**—To avoid chance of failure, the last-ditch protection uses three different detectors, any one of which is tripped by nuclear detonation, but not by any other type of explosion. Warning systems include a gamma ray detector, a thermal detector operated by infrared radiation from fission or fusion, and a blast pressure de-

(Continued on p 14)



Nuclear alarm, developed by Signal Corps, will button up underground installations upon nuclear attack

Business Briefs

▶ **Consolidation** of Thomas A. Edison and McGraw Electric is planned to form the McGraw-Edison Co. Edison, which recently borrowed $2.5 million (ELECTRONICS, p 14, Oct. 1956) would become the largest stockholder in the new company

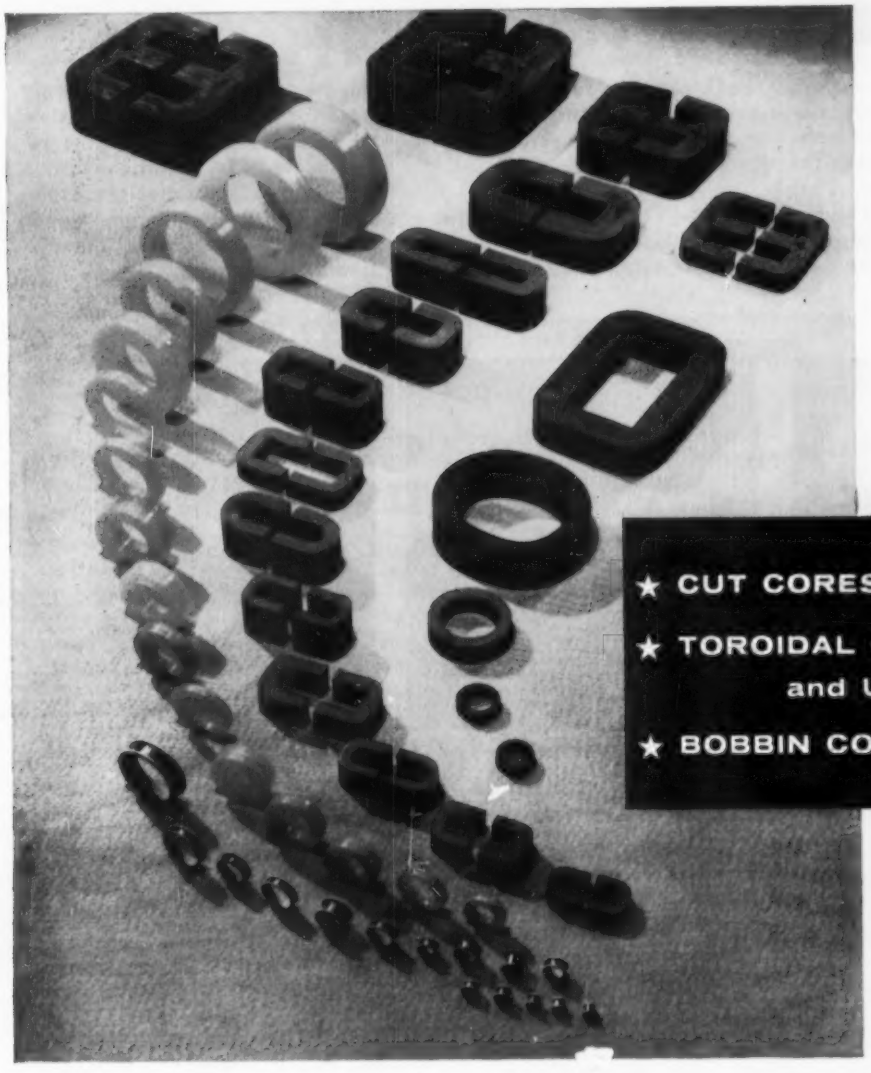
▶ **Selected** and prospective employees of Ramo Wooldridge may be able to buy stock in the firm at $10 per share when plans for the sale of 2,960 shares of Class B common stock, par $1, go through. Some 2,000 shares are subject to option by parent company, Thompson Products

▶ **Construction** of a new instrument building for Varian Associates will be financed by a $2-million loan agreement made with New York Life. Construction of a new microwave tube plant for the company will be financed from the sale of 94,750 shares of common stock selling at $12.75 per share. The company's sales volume is expected to reach $10 million this year

▶ **Tube** manufacturer, National Union Electric, which sold its cathode-ray tube plant to Sylvania in 1954, has agreed to buy the assets of Armstrong Furnace Co. in Columbus, Ohio

▶ **Stockholders** of Heli-Coil Corp. of Danbury, Conn. have approved acquisition of the company by Topp Industries of Los Angeles. Assets of the combined firms will total over $8 million and annual sales will approximate $10 million

▶ **Capacitor** manufacturing and selling expenses are behind U. S. Electronic Development Corp. plans to sell 299,990 shares of common at par, $1 per share



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MATERIALS: Deltamax, 4-79 Mo-Permalloy, Supermalloy, Mumetal, 4750, Monimax, Silectron, Permendur: all are available for cores depending upon the specific properties required.

GAUGES: The following standard tape thicknesses are available for Arnold tape wound cores in most of the magnetic materials mentioned above: .012", .004", .002", .001", .0005", or .00025". Bobbin cores are made from tape .001" to .000125" thick.

SIZES: Cores weighing from a fraction of a gram to many hundreds of pounds can be supplied. Toroidal cores are made in 27 standard sizes with nylon cases. Types "C" and "E" cut cores are made in a total of 530 standard sizes. Many special sizes and shapes of both gapless and cut cores are manufactured for unusual requirements.

OTHER PRODUCTS: In addition to Tape-Wound Cores, we also produce a complete line of Mo-Permalloy Powder Cores, Iron Powder Cores, and permanent magnets. • *Let us work with you.*

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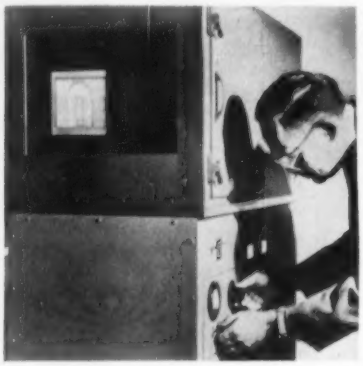
tector, also a poison gas detector.

The detectors are small aluminum cylinders, set on platforms atop steel towers surrounding the installation to be protected. They are wired to a control board underground. Activation of any detector flashes a warning light on the board. If the tower is destroyed, the system automatically goes into action regardless of the damage to the detectors.

► **Blast**—The system is immune to high-explosive blasts or thunderstorm false alarms. For example, the thermal detector senses only wave form of a nuclear detonation, while the gamma ray meter responds only to radiation with a high-rate, as in a nuclear explosion. All detectors ignore cosmic ray or other atmospheric radiation.



HOME television tape player, left, electronic air conditioner, center, and light amplifier are shown as . . .

Designs For The Future Move Toward Market

Progress in tv tape recording, light amplification and electronic air conditioning shown by RCA

ADVANCES in the development of a home magnetic tape recording system for tv, an electronic amplifier of light and an electronic air conditioner and refrigerator were demonstrated at RCA Laboratories on the occasion of David Sarnoff's fiftieth year in the industry. The firm estimates that each of the products should be on the market within five years.

► **Video Tape**—The home magnetic tape player for tv utilizes 26 tubes. It can feed a standard tv set pictures and sound recorded on ¼-inch magnetic tape.

A 7-inch reel provides 8 minutes of playing time and a 14-inch reel allows 33 minutes of playing time. The tape runs at 10 ft per second and takes a 2-mc bandwidth. Signals are impressed laterally along the tape.

The tape selections are recorded on the previously developed magnetic tape recording system for black-and-white and color tv now undergoing test at NBC. In development is an attachment for the tape player to permit the home user to record tv programs off the air or from a tv camera for original recordings. The laboratory is also working on techniques that will allow use of two tracks arranged side-by-side on the tape to double playing time.

► **Cooler**—The electronic air conditioning system shown comprises two wall panels, one 5 by 5 feet and the other 5 by 6 feet, with surfaces consisting of an array of 2-inch metal squares. A small cylinder of thermoelectric material is attached to the back of each square. The materials, alloys of zinc, lead or other metals, produce cold or heat by d-c depending upon the direction of current flow. In a small room, the system is capable of maintaining a room temperature as much as 25 degrees cooler or 25 degrees warmer than the temperature outside.

The new 4-cu ft refrigerator that was demonstrated operates on the principles employed in the electronic air conditioner.

► **Glow Panel**—The improved electronic light amplifier consists of a thin flat panel, that can increase by 1,000 times the visual brightness of a projected light image. It is also capable of converting invisible x-rays and infrared images to bright visible form.

The panel consists of a thin screen formed by two closely spaced layers, one of photoconductive material and the other of electroluminescent phosphor. Between these is a thin layer of opaque material to prevent feedback of light.

The layers are sandwiched between two transparent electrodes and a voltage is applied across the entire assembly. In operation, a dim light image falls on the photoconductive layer. This permits a corresponding pattern of electric current to flow through to the electroluminescent phosphor layer, which emits light, forming a high-brightness image of the original picture.

The ability of the light ampli-

(Continued on page 16)

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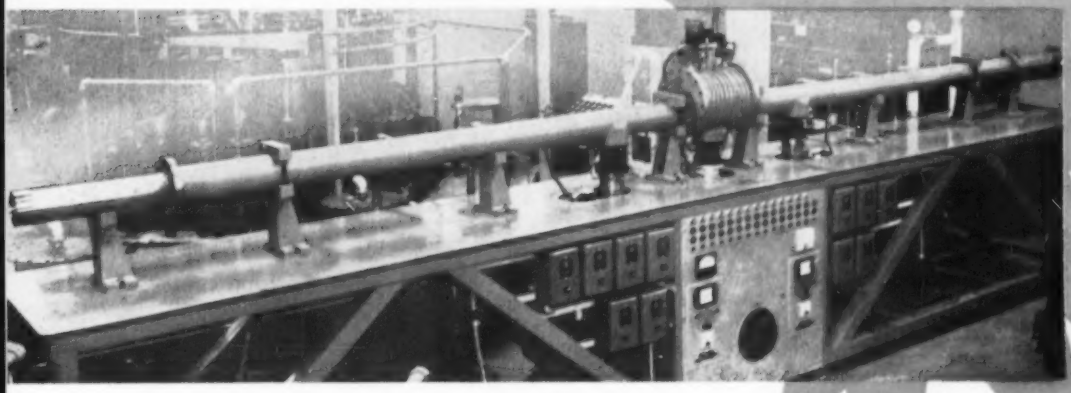
From Kahle . . . the **most advanced, most unique** Vacuum Firing Furnace ever developed . . . a Furnace that **never** loses its heat, or its vacuum during production . . . a Furnace that you **never** have to "pump down" or "turn off" under normal conditions.

The highly engineered, exclusive design of these new Kahle Vacuum Firing Furnaces provides **completely continuous** operation . . . it is destined to improve vacuum firing techniques of all types! Precision heat treating of such vital parts as tube plates, cathodes and grids . . . in vacuums as low as .01 micron . . . is now possible **at higher production speeds than ever before.**

Parts are always moved directly into the vacuum to insure better product quality; no mechanical levers or air cylinders are employed.

For versatility the heat zones of Kahle Vacuum Firing Furnaces are fully adjustable. Standard machines are supplied with resistance heating elements — other types upon request. Customized machines with viewing windows, automatic controls and other accessories can be created to fulfill your most exacting requirements . . . Kahle's new plant #2 provides improved delivery and enlarged engineering services. Need production equipment? "Call-on-Kahle."

Send for additional information on Vacuum Firing Furnaces and other Kahle Machines; please specify your application.



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fier panel to convert x-rays to visible light made possible the development of the amplifying fluoroscope for industrial use. The present device continues to emit its light for a few seconds after the x-rays have been cut off. Further research is expected to produce a photoconductive material that will respond faster to changes in x-ray light emission. This will make possible the development of an electronic amplifying fluoroscope for medical use.

ELECTRONIC brain aids analysis of human brain waves . . .

Computers Diagnose For Doctors

Experimental use in medical diagnosis underway. Air Force backs further development.

ADVANCES being made in basic computer capabilities may have important uses in the medical field. The Air Research and Development Command recently sponsored a conference on computers in medicine and jointly developed with American Machine And Foundry the period analyzer shown. ARDC is backing further developments in the field and several independent organizations along with computer manufactureres are considering the field.

▶ **Possibilities**—In diagnosis, particularly, ARDC sees wide spread potential usage of computers. Complete stores of all known signs and symptoms for both individual and categories of diseases might be coded and fed to computers.

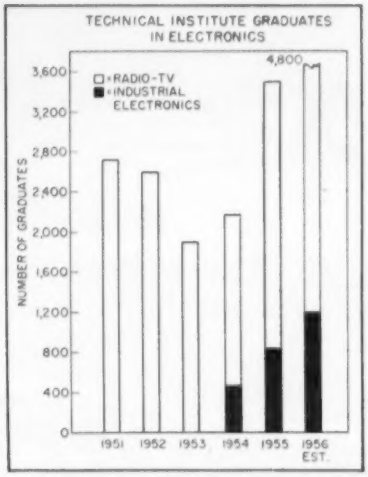
Careful lists of the clinical histories and physical findings assembled by the physician on any one patient could be matched against the store of knowledge in the computer. The resulting deductions should either produce a diagnosis or an indication of the special steps which should be followed to produce a definitive differential diagnosis.

In bio-medical research, many problems basically involve the solving of mathematical equations or the carrying out of lengthy statistical calculations. ARDC believes that the large scale general-purpose computers presently available would be widely applicable for this work.

The possibility of the building of complicated special circuitry, duplicating biological processes by using mathematical formulations, in much the same way that flight characteristics are simulated, also become evident.

▶ **Development** — Designed for faster and more accurate analysis of information presented by an electroencephalograph which detects and records human brain waves, the period analyzer shown measures physiological changes affecting the shape and frequency of the brain waves and reduces the data to one-fifth its original bulk. Still experimental, it distinguishes between degrees of sleeping and wakefulness and also correlates brain-wave patterns with oxygen deficiency in the blood. It makes possible future development of a device to correct this condition for pilots.

Tech Schools Combat Technician Shortage



Number of graduates increases sharply but a shortage continues as demand increases

TECHNICAL institutes are graduating an increasing number of technicians in the electronics field. Total of 2,652 in radio and television and 843 in industrial electronics curriculums were graduated last year, according to the twelfth annual survey of the field by McGraw-Hill. Present institute enrollments indicate that the number of graduates in electronics may reach 3,600 in radio and tv and 1,200 in industrial electronics next year. The survey covers 71 schools in the U. S. and 11 Canadian schools.

Number of graduates increased from technical institutes of all

(Continued on page 18)

Ideal Generator

for Audio and Ultrasonic Frequencies

Direct Reading 20 cycles to 40 kilocycles

Audio Spectrum 20 c to 20 kc in one sweep of dial

The versatile G-R Type 1304-B Beat-Frequency Audio Generator is the best test-signal generator for use at both audio and ultrasonic frequencies.

Type 1304-B Beat-Frequency Audio Generator: $575.00
(Available in either bench or relay rack models)

G-R offers several types of simple motor dial drives to convert the Type 1304-B generator and other manually-operated instruments to automatic sweep drives.

The Type 908-P1 is intended primarily for use with a graphic recorder since its synchronous motor provides convenient time base. Type 908-P2 has higher speed which is particularly suitable for limited sweep applications with oscilloscopes.

Both drives can be attached simply to the main frequency control in place of the knob. The motors are self-reversing; adjustable stops are provided for the dial to reverse the motor at any dial-position desired.

When used on the Type 1304-B Generator the sweep times are:

Type 908-P1 Synchronous Dial Drive: 50 sec/frequency decade or 15 sec/octave. Price: **$27.50**

Type 908-P2 Synchronous Dial Drive: 6¾ sec/frequency decade or 2 sec/octave. Price: **$27.50**

Essentially Constant Output Voltage — continuously variable from less than 5 millivolts to 50 volts — between 20 and 20,000 cycles varies less than ±0.25 db

Logarithmic Frequency Scale — scale length approximately 12 inches — frequency calibration accurate within ±(1%+0.5 cycle)

Extremely Low Distortion — total harmonic content less than 0.25% from 100 to 10,000 cycles

High Frequency Stability — drift from cold start less than 7 cycles in first hour; essentially complete in 2 hours

Very Low Hum — less than 0.1% of output voltages above 10% of full scale

Accurate Output Voltmeter calibrated in open circuit output voltage and in dbm — used as zero beat indicator and also as frequency calibrator in terms of line frequency

Dial Can Be Motor Driven with several combinations of G-R Dial Drives to plot frequency characteristics automatically with graphic recorders

Frequency-Increment Dial calibrated +50 to −50 cycles with accuracy of ±1 cycle

Balanced Or Unbalanced Output Connections

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Mass., U.S.A.

Broad Avenue at Linden, Ridgefield, N. J. **NEW YORK AREA** 920 S. Michigan Ave. **CHICAGO 5**

1150 York Road, Abington, Pa. **PHILADELPHIA**

8055 13th St., Silver Spring, Md. **WASHINGTON, D. C.** 1000 N. Seward St. **LOS ANGELES 38**

WE SELL DIRECT
Prices are net, FOB Cambridge or West Concord, Mass.

kinds, according to the study. It appears that these institutes are beginning to feel the bulge of students that have been moving through high schools.

► **Biggest Share**—There were more graduates in radio, tv and industrial electronics curriculums from technical institutes in 1955 than in any other single classification. They accounted for approximately 31 percent of all technical institute graduates. Most electronics graduates were from private technical institutes, followed by privately endowed institutes, extension divisions of colleges or universities, state and municipal schools and YMCA schools.

► **Need**—Despite increases in engineering technician graduates, the number falls far short of present needs, according to the technical institute division of the American Society for Engineering Education. An ASEE survey shows that there were 11,403 graduates from full-time technical institute programs this year.

It is currently estimated that the annual demand for engineering technicians is approximately 40,000 to 50,000, nearly five times the number graduating from full-time programs this year. To meet this demand for graduates, enrollments would have to increase to between 150,000 and 200,000. If this need is to be met, a great increase in the number and quality of schools is required.

Military Electronics

► **Sixty-million** dollar contract to produce air-to-air guided missiles for Naval aviation was awarded to Raytheon by the Bureau of Aeronautics. Prior to the order, the company's government backlog totaled about $180 million, almost double that of a year ago

► **Obsolete** military electronic equipment worth $5 million is being studied by Air Materiel Command electronics experts to find ways to renew its usefulness and marketability

► **Six** small cargo ships are to be used by the Air Force as missile tracking and data stations over the South Atlantic between St. Lucia and Ascension Islands to supplement land stations of the Missile Test Center in Florida

► **Royal** Canadian Air Force's new jet combat planes will use an electronic weapon system designed and developed by RCA and Minneapolis Honeywell. The U. S. Air Force awarded a multi-million dollar contract to the companies for the job

► **Armed** Forces Electro-Standards Agency program of performing qualification tests of military electronic equipment with the test facilities of commercial laboratories and electronic parts manufacturers, is being extended to include the facilities of electronic equipment manufacturers

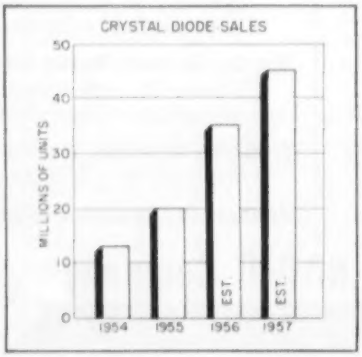
► **New** $1.3 million order for 2,000 AN/GRC-9 radio sets, awarded to Lewyt by Signal Corps, boosts the company's production of the sets to about $28 million

► **Development** contract awarded Sperry Gyroscope for a general purpose microwave command guidance system capable of precisely controlling highly-specialized drones at supersonic speeds will total $4.5 million

Crystal Diode Sales Near 35-Million Units

Computer business helps increase. Dollar volume may exceed $31 million for the year

CRYSTAL diodes put to work this year are expected to hit 35 million, nearly doubling 1954 output of 20-million units. Sylvania, which recently produced its 23-millionth diode at its Woburn plant, expects some 45-million crystal diodes to be produced next year at an annual billing exceeding $42 million.



► **Doubling**—Dollar sales of crystal diodes went from $9.3 million in 1954 to $18.4 million in 1955. This year's output of 35-million units is expected to produce dollar sales of $31.8 million.

► **One Use**—One factor behind the increasing production and sales of crystal diodes is the growing computer market. Size of this business from just one computer firm is indicated from a recent

(Continued on p 20)

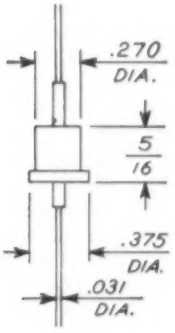
another RAYTHEON first!

Actual Size

SOLID STATE *DIFFUSED JUNCTION*

SILICON RECTIFIERS

now in QUANTITY PRODUCTION



Uniform Characteristics — Uniformly High Quality

The Solid State Diffusion Process involves the formation of a junction by diffusing suitable gaseous materials into silicon at high temperatures. This process offers many advantages including:

1. Exact control of junction penetration.
2. Precise junction gradient for specific rectifier applications.
3. Flat junctions for uniformity and control of characteristics.

Operating Temperatures — minus 65°C to plus 150°C

Storage Temperature — up to 170°C

Hermetically Sealed — Welded

AVERAGE CHARACTERISTICS

Type	Peak Inverse Volts*	Forward Current** milliamperes 100°C	150°C	Forward Volts*** at 350 mA 100°C	Reverse Current*** (max.) mA at rms volts 100°C
CK840	100	350	100	0.75	0.2 at 70
CK841	200	350	100	0.75	0.2 at 140
CK842	300	350	100	0.75	0.2 at 210
CK843	400	350	100	0.75	0.2 at 280
CK844	500	350	100	0.75	0.2 at 350
CK845	600	350	100	0.75	0.2 at 420

*PIV ratings apply from −65°C to +150°C

**Into inductive or resistive load

***Averaged over one complete cycle

RAYTHEON

SEMICONDUCTOR DIVISION

Silicon and Germanium Diodes and Transistors • Silicon Power Rectifiers

NEWTON, MASS.: 150 California St. • DEcatur 2-7177
NEW YORK: 589 Fifth Ave. • PLaza 9-3900
CHICAGO: 9501 Grand Ave., Franklin Park • TUxedo 9-5400
LOS ANGELES: 5236 Santa Monica Blvd. • NOrmandy 5-4221

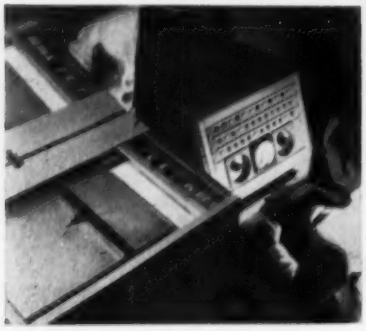
order placed by Logistics Research.

The firm ordered one-million germanium diodes from Hughes Aircraft for use in the ALWAC computer and other data processing equipment. Each ALWAC requires about 6,000 diodes.

Logistics expects further increases in the purchase of diodes for use in its new ALWAC 800 computer which will require 20,000 diodes.

▶ **Development**—Registered with JETEC last year were some 107 types representing nearly 40 percent of total diode registrations since 1946. In 1954, 65 types were registered and in 1953, the total was 43.

Silicon diodes have moved ahead in number of registrations. Of more than 270 types registered since 1946, 57 percent have been silicon types. (ELECTRONICS, p 16, April, 1956). Today, about 40 companies in the U. S. manufacture semiconductor diodes compared to 25 in 1954.



ELECTRONIC brain that profits from its own mistakes (left), a new vibrating-reed gyro (center) and a better insight into superconductors (right) show how . . .

Industry Increases Spending For Research

Expansion of industrial laboratories points up industry trend to higher expenditures

MORE than $5 billion is now spent on applied and basic research in all fields in the U. S. This is over 20 times that spent in the 1920's. The electrical-electronic industry spends about one-fifth, or $1 billion, on this same research.

Further evidence of the trend in expansion of research is shown in the 200,000 professional scientists and technicians now engaged on fulltime research compared to 9,000 in 1920 and 4,000 firms maintaining laboratories compared to 220 in 1920. Added to this is the fact that the federal government maintains 53 laboratories.

▶ **Latest**—Most recent example of this expansion is the dedication of the new Westinghouse Research Laboratories in Pittsburgh, Pa. where about $2½ million will be spent this year on purely fundamental research. This represents forty percent of the effort at this laboratory, the remaining effort is concentrated 50 percent on basic research and 10 percent on applied research.

▶ **Brain**—Automex, derived from automatic experimenter, is the result of research in the field of mathematics and process control. The device can be designed to accept a number of variables as input data and arrive at a solution by taking a minimum number of discrete steps, each of which is experimental and provides the basis on which the next step is taken.

▶ **Gyroscope** — Vibragyro is the name given to a different type of rate gyro operating on the principle that vibrating masses, such as on a tuning fork, will oscillate about their input axis on application of an input torque. The amplitude of oscillation is proportional to input rate-of-turn or velocity while the phase of the oscillation compared to the phrase of the vibrating masses represents the input direction. Applications include use in missiles, aircraft and in stable elements on ships.

▶ **Cryogenics** — The field of low-temperature physics is receiving ever-increasing interest because of the great potential inherent in superconductors. Microwaves in the 200-kmc range are being used to bombard superconductors to determine the properties of these metals. In a typical experiment, the microwave power absorbed by the superconductor is about 1 millionth of a watt. This raises its temperature about 1 thousandth of a degree enabling scientists to determine when the metal changes from the superconducting to the normal conducting state.

High-Fidelity Makers See Expanding Sales

Both component and package manufacturers in the field are doing big business

NEW YORK High-Fidelity Show and Audio Engineering Society Convention served to point up the continuing growth of the high-fidelity field. Although there is no agreement as to what is and what isn't

(continued on p 22)

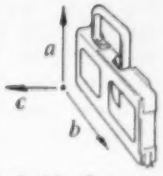
Starfighters' Fire-control Radars Use Barry's NEW Integral* Mounting Systems

In the most advanced airplane of its type ever developed — Lockheed's F-104A Starfighter — Barry's new Integral* Mounting Systems are solving the toughest combination of shock, vibration, and sustained-acceleration problems ever posed by jet aircraft. Literally a "missile with a man in it", the F-104A demands that equipment mounts give superior performance, in less space, and at lighter weight than ever before.

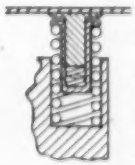
Here's how Barry's Integral* Mounting Systems are meeting this demand in the production models of the Starfighter.

In a space only 12¾ x 5⅜ x 1-13/32" on each side of a 150-pound load . . . a pair of units weighing less than three pound. each . . . provides adequate vibration isolation at 4g sustained acceleration in all radial directions . . . passes all shock-test requirements of this supersonic fighter . . . performs reliably through wide temperature and altitude ranges . . . and provides positive, quick-release attachment to the airframe to satisfy Lockheed's requirements for "plug-in" electronics-system components.

Here's the way this system works.



Helical springs designed to function in their axial direction only are grouped about the load attachment points so as to provide controlled resistance to movement along the *a* and *b* axes. For the *c* axis, resistance is provided by the slightly tapered side flanges of the mounting frame working against the displacement of all the load-carrying springs.



Damping adjustments (see diagram), completely independent of the stiffness of the load-carrying springs, provide design flexibility for obtaining desired natural frequency, transmissibility at resonance, and degree of vibration and shock isolation.

Write for THO-5 containing a full exposition of this All-Angl Integral* Mounting System.

BARRY CONTROLS
INCORPORATED

BARRY B MOUNT

SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

707 PLEASANT STREET, WATERTOWN 72, MASSACHUSETTS

***Integral means . . .**
Designed specifically for the environment performance requirements.
Built specifically for the equipment.
You can save time, space, and trouble by bringing your shock and vibration problems to us. Call your Barry sales representative.

Want more information? Use post card on last page.

high-fidelity equipment, all segments of the business, from manufacturers of components to makers of popular-priced packaged units, agree that the growth of the field is continuing strong.

Paid attendance at the show, sponsored by the Institute of High Fidelity Manufacturers, reached over 30,000. More than 95 exhibitors displayed their wares. At the Convention, 43 papers were presented covering subjects ranging from a hot stylus to audio in salmon research.

▶**What is Hi-Fi?**—Without definite standards, estimates of the annual sales volume of the hi-fi field vary widely. Manufacturers of popular-price package units give estimates exceeding $500 million for what they consider the total hi-fi business.

Component manufacturers place present annual industry-wide sales at between $70 and $80 million for home-assembled systems. Both types of manufacturers see sales continuing to rise through 1960. One component maker estimates that home-assembled hi-fi systems will grow from 600,000 units sold this year to 1.4 million units in 1960.

▶**Seek Answer**—One entire session at the New York convention was devoted to standards and measurements. The hope is that all comparable items of hi-fi equipment can eventually be measured by the same yardstick.

FCC Actions

▶**Adopted** technical standards providing for split channels in vehicular radio systems using frequencies between 152 and 162 mc

▶**Met** with Coast Guard, Maritime Administration and industry groups to discuss automatic radiotelegraph call selectors and other safety devices

▶**Urged** mobile licensees using frequencies in the 25-50 mc band to move to higher assignments, as recommended over a decade ago by the late E. H. Armstrong

▶**Invited** comments on proposal that frequency assignments below 25 mc to industrial radio stations be made on a case-by-case basis

▶**Agreed** with Canadian Department of Transport on addition of Channel 5 for Pembroke, Ontario and Channel 7 at New Glasgow, Nova Scotia

▶**Denied** petitions to establish a radio burglar and fire alarm service

▶**Called** for comments on use of frequencies between 159.51 and 161.79 mc for tone control signals as suggested by railroad interests

▶**Relaxed** broadcast station requirement for identification of recorded programs. Often, only a single daily announcement is required

▶**Clarified** rules that limit radiation of frequencies between 450 kc and 25 mc from radio and television receivers tuned from 30 kc to 890 mc

▶**Gave** communications organizations shared use, with electric power groups, of six frequencies near 450 mc for maintenance and construction purposes

New Atomic Clock Improves Air Navigation

Chief use of 90-tube timepiece is as frequency standard for long-range navigation systems

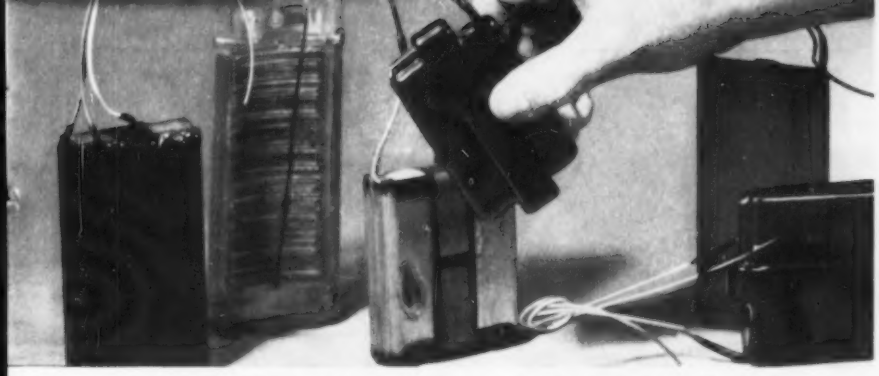
CESIUM atoms serve in place of a pendulum in National Co.'s Atomichron, to give a new high in accuracy for time and frequency standards. Demonstrated stability is one part in 100 billion, which is equivalent to less than 1 second of time drift in 3,000 years.

▶**How It Works**—Heart of the system is a long vertical tube having a pool of cesium at the bottom. When heated, individual atoms drift up through the tube at the speed of sound. Atoms having one energy state get through one magnetic field, are flipped over to the other energy state by r-f at the resonant frequency of cesium, then get through the uppermost magnetic field to a target and electron multiplier.

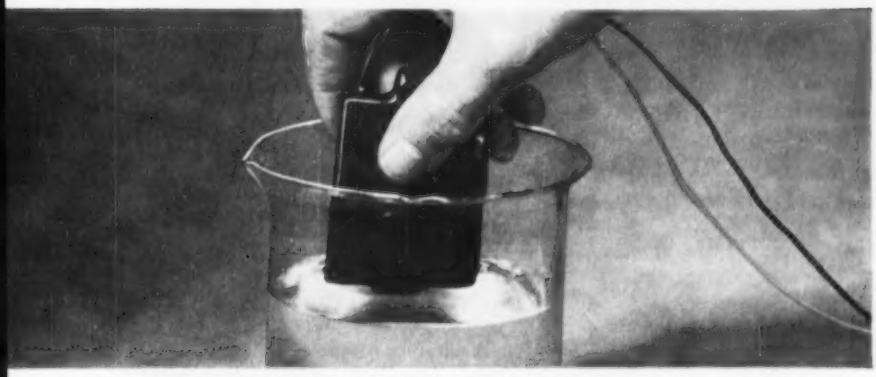
National's atomic clock showing long atom beam tube mounted vertically

The 90-odd electron tubes generate and maintain the r-f input at exactly the resonance frequency of cesium (9,192.631830 mc). When the generated frequency deviates, fewer atoms hit the target, the out-

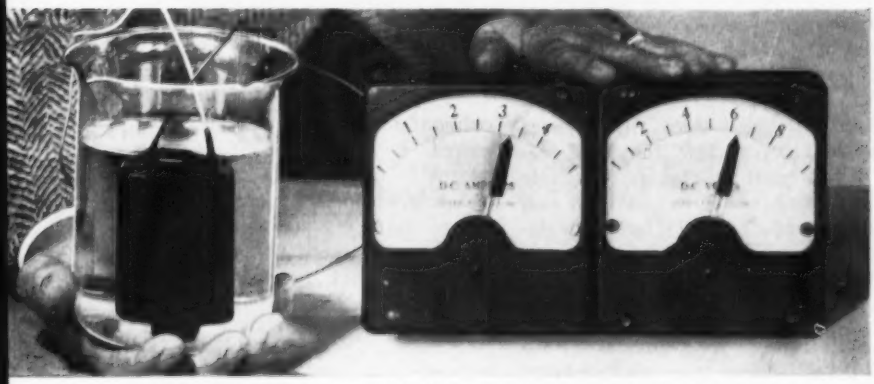
(Continued on page 24)



DRY G-E water-activated batteries are made dry, stored dry. Contain no electrolyte to leak or freeze. Demand no maintenance during storage other than normal precaution against moisture.



WET To activate, simply immerse in water. Batteries reach operating voltage as fast as 2 seconds . . . operate efficiently in extreme temperatures . . . are unaffected by external hydrostatic pressure.



POWER These silver-chloride/magnesium type batteries deliver up to 42 watt hours per pound and 3 watt hours per cubic inch, with nearly level power output over total operating life.

General Electric's

New Water-Activated Batteries Deliver up to 42 Watt Hours Per Pound!

WHERE CAN YOU USE G-E WATER-ACTIVATED BATTERIES? Probably wherever you need a versatile source of d-c power, wrapped inside a small, lightweight package.

Delivering tremendous power for relative size and weight, these primary batteries can be used as "power packs" in any number of series, parallel, or series-parallel combinations you may need.

Though a wide range of ratings and sizes is available, G-E water-activated batteries can be designed in nearly any combination of sizes, weights, and ratings to fit your specific application.

Examine your power needs now. If space, weight, and exceptional reliability are critical, phone your G-E Apparatus Sales Office, today. A representative will be glad to give you additional information on how G-E water-activated batteries can help solve these problems.

GENERAL ELECTRIC

For descriptive bulletin GEA-6238A on G-E water-activated batteries, send coupon to:

General Electric Co., Section A223-5
Schenectady 5, N. Y.

☐ for immediate project ☐ for reference only

Name .....

Position .....

Company .....

Street .....

City ..... State .....

put current drops slightly, and the electronic control circuits automatically react to bring the frequency back to resonance.

► **Operating Details**—The atomic beam tube is guaranteed to furnish atoms for a minimum of 1,000 hours.

With about 0.5 microgram consumption or cesium atoms per day, the theoretical life of the atom supply is 20 to 40 years.

► **Applications**—Accuracy is better than direct reception of WWV signals, and much better than sky-wave signals from WWV.

Seven units have been built. One is at the Air Force's Navarho ground station near Rome, N. Y. Installed in the distance-measuring equipment, it gives such improved frequency stability that a pilot anywhere within 2,000 miles can determine exact distance from the base to an accuracy of 1 percent. A 600-mph jet can stay tuned to this one station for entire cross-country flights and even on to the Azores in the Atlantic.

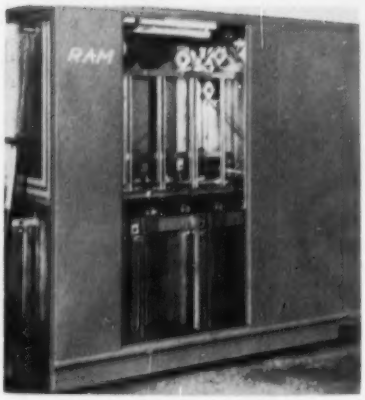
Financial Roundup

Only three companies out of 14 reporting had lower net profits this year compared to 1955

MANUFACTURERS in the electronics field have enjoyed increased profits during 1956, for the most part. This is indicated in the net profit statements of the following manufacturers for the fiscal periods indicated:

Company	Net Profit 1956	1955
Beckman Inst. 12m	$1,744,856	$1,322,050
Cornell-Dubilier 9m	718,093	1,381,448
EECO 6m	50,965	30,744
IBM 9m	49,234,012	38,437,353
ITE Circuit Breaker 6m	6,135,549	3,227,911
IT&T 6m	12,487,250	4,411,701
Litton Industries 12m	1,019,703	436,413
Magnavox 12m	3,100,442	2,426,087
Minn. Mining 6m	17,814,767	15,969,268
Raytheon 3m	313,000	764,000
Siegler 12m	1,053,059	774,571
Universal Winding 12m	654,388	*197,320
Westinghouse Air Brake 6m	6,135,549	3,227,911
Topp Industries 12m	92,062	130,274

* Loss



MAGNETIC tape is strung in vertical columns on movable pages of Potter equipment so that . . .

Memory Capacity Tops Half Billion

Fast access tape memory uses 60 miles of recording track for increased storage

ONE major roadblock to the completely automatic office and factory has been the lack of a large-scale fast-access memory system. Existing data-processing systems are capable of handling transactions with split-second efficiency but these systems do not fit all applications, especially where more than a few thousand decisions must be stored. Magnetic tape machines have provided useful storage capacity but time delays in the order of minutes may be involved when complete random access to stored information is required.

► **RAM**—Potter Instrument has introduced a Random Access Memory designed to help smooth the road to the automatic office and factory. It is capable of storing and processing more than 500 million bits of information in as many as 400,000 locations with access to any desired location in a fraction of a second. Its capacity is equivalent to 13 of the largest capacity random access mechanisms available today, according to the company.

► **Applications**—Typical uses for the device include maintenance of magazine subscription lists, insurance company records, banking transactions, inventory control, and as an external memory for high-speed digital computers and data-processing systems. Input devices that can be used with the machine include keyboards, magnetic tape, perforated tape or information directly from a computer.

► **Works**—The speed and capacity of the new system are made possible by the 3-dimensional physical configuration shown. Data are stored on conventional 8-track magnetic tape strung in vertical columns on pages which can be raised to bring a selected data location in contact with the record-playback head. The storage bin holds 200 pages and can be enlarged.

Closed-Circuit TV Picks Up Volume

Manufacturers gird for sales expansion. New applications and developments spur activity

INTRODUCTORY phase of closed-circuit tv has passed and its wide acceptance by industry now calls for more intensive manufacturing and marketing activity, according to a leading manufacturer of the equipment.

This recent statement seems

(Continued on p 26)

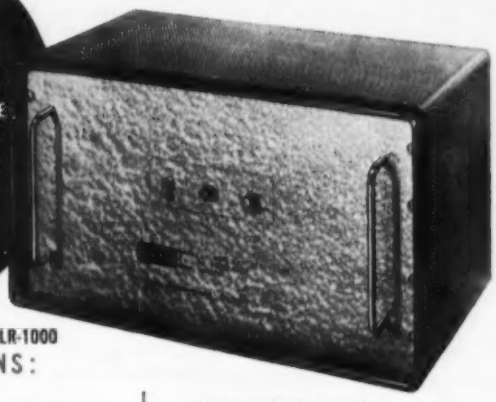
New 1 KVA Perkin

Tubeless magnetic amplifier

AC Line Regulator features ±0.25% regulation accuracy

FOR ANY COMBINATION OF LINE OR LOAD

NO TUBES
MOVING PARTS OR
VIBRATING CONTACTS
•
REGULATES RMS VALUE
RACK PANEL OR
CABINET MOUNTING
•
IDEAL FOR
UNATTENDED
INSTALLATIONS



Model MLR-1000

SPECIFICATIONS:

Input voltage range: 95 to 135 volts

Output voltage: Nominal 115 volts, can be adjusted from 110 to 120 v.

Output current: 8.5 amperes

Frequency range: 60 cycles ±10%

Wave form distortion: 3% max.

Power factor range: 0.5 lagging to 0.9 leading

Response time: 0.2 sec.

Maximum load: 1.0 KVA

Ambient temp. range: Up to 45° C

Dimensions: 19½" wide x 11½" high x 11½" deep (Cabinet)
19" wide x 10½" high x 10" deep (rack panel)

Mounting: Cabinet or 19" rack panel

Finish: Gray hammertone

Weight: 85 lbs.

Also available—3 KVA Model MLR-3000, same specifications except: output current 25.5 amps. Dimensions 19" wide, 14¾" deep x 12¼" high (rack) or 19½" wide x 16¼" deep x 12¾" high (cabinet). Weight 170 lbs.

PERKIN

DC POWER SUPPLIES

Perkin also manufactures a complete line of standard DC power supplies as listed below:

28 VOLT DC POWER SUPPLIES:

Model	Volts	Amps	Reg.	AC Input (60 cps)	Ripple rms
28-5VFM	0-32 V	5	20% (24-32 V range)	115 V 1 phase	2%
28-10WX	24-32 V	10	±½%	100-125 V 1 phase	1%
MR632-15A	2-36 V	15	±½%	105-125 V 1 phase	1%
28-15VFM	0-32 V	15	20% (24-32 V range)	115 V 1 phase	5%
28-25V	0-32 V	25	±1%	115 V 1 phase	1%
MR1040-30A	5-40 V	30	±1%	100-130 V 1 phase	1%
28-30WXM	24-32 V	30	±½%	100-125 V 1 phase	1%
28-50WX	24-32 V	50	±½%	230 V* 3 phase	1%
MR2433-100XA	24-32 V	100	±½%	200, 230, 460 V ±10% 3 phase	1%
MR2432-200	24-32 V	200	±½%	230 V* 3 phase	1%
MR2433-300	24-32 V	300	±½%	230 V* 3 phase	1%
MR2432-500	24-32 V	500	±½%	230 V* 3 phase	1%

*±10%. Also available in 460 V ± 10% AC input. Will be supplied with 230 V input unless otherwise specified.

6, 12, 115 VOLT DC POWER SUPPLIES:

	Model	Volts	Amps	Reg.	AC Input (60 cps)	Ripple rms
6 Volt	6-5WX	6 ±10%	5	±1%	95-130 V 1 phase	1%
	6-15WX	6 ±10%	15	±1%	95-130 V 1 phase	1%
	6-40WX	6 ±10%	40	±1%	95-130 V 1 phase	1%
12 Volt	12-15WX	12 ±10%	15	±1%	95-130 V 1 phase	1%
115 Volt	115-5WX	115 ±10%	5	±½%	95-130 V 1 phase	1%
	MR19135-8	19-135	8	±1%†	95-130 V 1 phase	1%†
	8735-25**	115-125	25	1½-4%	230/460 V 3 phase	5%

**Germanium Rectifier Unit †Increases to 2% @ 15 V.

Write factory or call for prices . . . Write for catalog.

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LEADER IN TUBELESS MAGNETIC AMPLIFIER REGULATION

PERKIN ENGINEERING CORPORATION

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to keynote present activity in the field.

► **Volume**—Estimates of the sales volume of industrial tv still vary widely. One manufacturer estimates annual industry-wide volume at $6 million and sees an increase to more than $75 million annually within 10 years. Another manufacturer in the field estimates that 1956 sales will total $3 million of the vidicon type of industrial tv equipment. By 1960 the firm sees an overall volume of $8 million.

An industrial tv tube manufacturer estimates that 1955 volume doubled that of 1954 and that 1956 sales will be five times greater than last year's. It expects 1957 sales of the equipment to double 1956 volume.

► **Sales Plans**—General Electric has stepped up its sales activities in various segments of the market. Sales activity for the remainder of this year will be concentrated primarily in the manufacturing, transportation and utility areas and some parts of defense.

Jerrold Electronics, also increasing its sales activities, recently surveyed industrial use of the equipment. This showed that although many firms are interested in industrial tv, few know how to apply it to their operations. As a result, the company is putting a closed-circuit system on the road to demonstrate before professional and technical groups how closed-circuit tv can be applied to individual business operation.

► **Product**—Westinghouse recently announced that it is working on a new principal in the development of a tv pickup tube that may be 100 times more sensitive.

RCA has announced development of an improved vidicon tube that will go into commercial production early in 1957. The tube has a tipless structure that allows use of a longer deflecting yoke. The longer yoke needs less deflecting power and has a narrower deflecting angle which reduces deflection distortion and improves center-to-edge focus of the scanning beam.

Meetings Ahead

Oct. 29-30: East Coast Aeronautical & Navigation Conference, IRE, Fifth Regiment Armory, Baltimore, Md.

Oct. 29-Nov. 2: International Convention On Ferrites, British IEE, London, England.

Nov. 7-9: Ninth Annual Conference On Electrical Techniques In Medicine And Biology, IRE, AIEE, ISA, Gov. Clinton Hotel, New York, N. Y.

Nov. 8-9: Kansas City IRE Technical Conference, Town House Hotel, Kansas City.

Nov. 14-16: Symposium on Optics and Microwaves, IRE, G.W. University, Lisner Auditorium, George Washington University, Washington, D. C.

Nov. 15-16: New England Radio Engineering Meeting, IRE, Hotel Bradford, Boston, Mass.

Nov. 26-30: Third International Automation Exposition, New York Trade Show Bldg., New York, N. Y.

Nov. 29-30: IRE, PGVC Annual Meeting, Fort Shelby Hotel, Detroit, Mich.

Nov. 29-30: Operations Research Conference, SAM, Hotel Commodore, New York, N. Y.

Dec. 3-4: Midwest Symposium On Circuit Theory, IRE, Michigan State University, East Lansing, Mich.

Dec. 5-7: Second IRE Instrumentation Conference & Exhibit, Biltmore Hotel, Atlanta, Ga.

Dec. 10-12: Eastern Joint Computer Conference, IRE, AIEE, ACM, Hotel New Yorker, New York, N. Y.

Jan. 14-15: Symposium On Reliability & Quality Control In Electronics, IRE, NBS, ASQC, Statler Hotel, Wash., D. C.

Jan. 23-25: IRE, Symposium On Very Low Frequency Waves, NBS, Boulder Labs, Boulder, Colo.

Jan. 28-29: Symposium On Microwave Ferrite Devices & Applications, IRE, Engineering Societies Bldg., New York, N. Y.

Jan. 30: Electronics In Aviation Day, IRE, IAS, RTCA, Sheraton Astor Hotel, New York, N. Y.

Feb. 7: Annual Mid-Winter Symposium Aircraft Instrumentation, New York ISA, Garden City Hotel, New York.

Feb. 14: Symposium On Recording Of Heart Sounds, IRE, University Of Buffalo Medical School, Buffalo, N. Y.

Feb. 14-15: Conference On Transistor Circuits, IRE, AIEE, Phildelphia, Pa.

Feb. 26-28: Western Joint Computer Conference, IRE, AIEE, ACM, Statler Hotel, Los Angeles, Calif.

Mar. 18-21: IRE National Convention, Waldorf-Astoria Hotel, New York Coliseum, New York, N. Y.

Industry Shorts

► **Football** helmet equipped with radio receiver used by the Cleveland Browns in a game with the Detroit Lions, allowed the coach to instruct his quarterback without rotating guards. Set was developed by salesman for Thomas A. Edison Co. Now the Lions are wiring for sound.

► **One** of three color tubes selected at random from RCA production lines for life test has been operating for more than 10,000 hours. Two others have already exceeded 5,000 hours.

► **Contracts** totaling $1.5 million have been awarded by CAA to 39 different contractors for 445,994 electron tubes. Total of 445 different types have been ordered ranging in price from 22 cents to $1,530.

► **Television** picture tube employing 110-degree diagonal deflection has been developed by RCA. Over-all length is 14.5 inches compared to 20 inches for the same type tube with 90-degree deflection.

► **Portable** battery operated public address system priced at $375 has been developed by Lustraphone of England. It weighs 24.5 pounds and has a 10 watt power amplifier that uses Clevite transistors.

Now . . .

A 50 *Megacycle* Vacuum Tube Voltmeter and *Video Amplifier*

with the new

KAY *Microlter*

WIDE BAND . . . HIGH FREQUENCY . . . LOW LEVEL VACUUM TUBE VOLTMETER PERMITS 250 MICRO-VOLT MEASUREMENTS AT 50 MEGACYCLES!

Through the use of a unique new design, the new Kay Microlter permits measurement of extremely low voltages at frequencies higher than all existing vacuum tube voltmeters — yet reduces all steady state changes and line voltage variations.

Simple To Operate — No Tuning Required

The Microlter permits complete ease of operation by most personnel. No tuning is required and the meter is direct reading. A single 7-position switch provides *full scale* steps of 1, .3, .1, .03, .01, .003, and .001 v., with the lowest reading at 250 microvolts!

A high impedance probe employing a subminiature tube as a cathode follower is used to drive the wide-band amplifier. The resistive component of the impedance for low frequencies is approximately 1 megohm, decreasing progressively with frequency to 30,000 ohms at 50 megacycles. Probe may be soldered to unit under test.

SPECIFICATIONS

Frequency Range:
100 cycles to 50 megacycles.

Direct Reading in Voltage Or Decibels.

Accuracy:
± 10% of full reading.

Freq. Response:
± 1db.

Voltage Range:
1 millivolt to 1 volt full scale in 7 ranges.

Sensitivity:
Will measure down to 250 microvolts.

Input Impedance:
Capacitance 5 micromicrofarads, resistance loading dependent upon frequency (1 megohm at 1 megacycle to 30,000 ohms at 50 megacycles).

No Tuning:
May also be used as a wide band video amplifier, maximum output approximately .25 volts at 75 ohms. Gain of up to 44 db.

Price:
Model 50: $495.00 FOB Plant.

WRITE FOR NEW KAY CATALOG

KAY ELECTRIC COMPANY

14 MAPLE AVENUE *Dept. E-11* *CAldwell 6-4000* **PINE BROOK, N. J.**

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This MARCONI F.M./A.M. Signal Generator

COVERS ALL MOBILE COMMUNICATION BANDS

The new Marconi Signal Generator type 1066/1 meets all requirements for the design and maintenance of f.m. equipment in the range 10-470 Mc. Here is a precision Marconi instrument for an exacting job.

The oscillator works on fundamentals throughout and there are no spurious sub-multiple outputs; its temperature compensation and fully-regulated plate and filament supplies give excellent frequency stability. A magnetically-biased ferrite frequency modulator ensures rock steady deviation characteristics. Other major features are the Marconi-patented contactless range turret and a 50Ω piston attenuator which is truly resistive. Engineers will appreciate the separate incremental frequency controls with meter calibration; these enable precise f.m. carrier shifts of as little as 1 kc in 450 Mc without readjustment of main frequency control.

MARCONI F.M./A.M. SIGNAL GENERATOR TYPE 1066/1

ABRIDGED SPECIFICATION

Frequency Range: *10 to 470 Mc in five bands—all on fundamentals* • Frequency Stability: *Better than 0.0025% per 10 minute period after warm-up* • Modulation, F.M.: *0 to 20 and 0 to 100 kc deviation, monitored and continuously variable* Modulation, A.M.: *0 to 20 and 0 to 40% depth, monitored and continuously variable* • Modulation Frequencies: *1 and 5 kc* • Distortion Due to Modulator: *Less than 1%* • Output: *0.1 μV to 100 mV across a 50Ω termination* • Output Accuracy: *Incremental, 0.2 dB; within 2 dB overall* Leakage: *Negligible; allows full use of 0.1 μV output* • Incremental Frequency Controls: *Variable, 0 to ±100 kc. Stepped, ±5, 10 and 15 kc* • Tubes: *5Z4G, 6AK6, 6CD6G, 6AK5, 5861, 6C4, 6L6G, 12AX7, 0B2, 85A2.*

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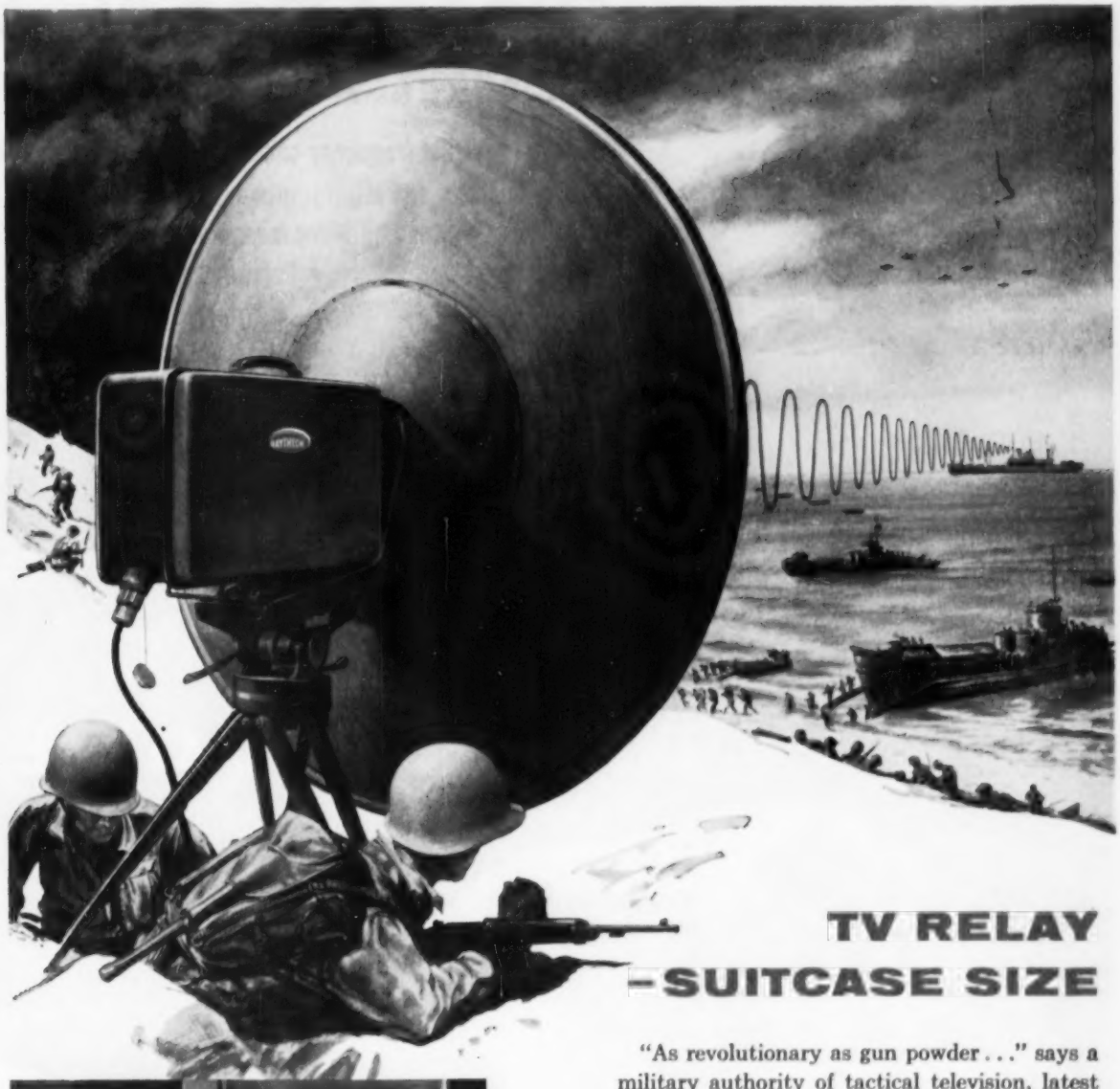

TV RELAY –SUITCASE SIZE

"As revolutionary as gun powder . . ." says a military authority of tactical television, latest communications device of the armed services.

Pictures of amphibious landings, battlefield surveillance and relayed aerial reconnaissance are transmitted instantly to the point of tactical command by Raytheon's KTR microwave relay. Lightweight, compact, rugged and powerful, this unit gets the picture through under toughest conditions.

In civilian life, the KTR relay serves television broadcasters, utilities and common carriers, helps control traffic and keeps an eye on industrial processes. This versatile unit is further evidence of Raytheon's *"Excellence in Electronics"*.

Excellence in Electronics RAYTHEON

RAYTHEON MANUFACTURING COMPANY
WALTHAM 54, MASSACHUSETTS

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Direct Reading Spectrum Analyzer

for
- Visual frequency calibration — high resolution
- Leakage and interference measurements
- Standing wave measurements
- Pulse modulation analysis
- Sensitive receiver

The BASIC SCOPE for VISUAL MICROWAVE

SPECIFICATIONS

Model No.	Equipment
Model Du.....	Spectrum Display and Power Unit
Model STU-1...	RF Tuning Unit 10-1,000 mc.
Model STU-2A.	RF Tuning Unit 910-4, 560 mc.
Model STU-3A.	RF Tuning Unit 4,370-22,000 mc.
Model STU-4...	RF Tuning Unit 21,000-33,000 mc.
Model STU-5...	RF Tuning Unit 33,000-44,000 mc.

Frequency Range: 10 mc to 44,000 mc.
Frequency Accuracy: ±1%
Resolution: 25 kc.
Frequency Dispersion: Electronically controlled, continually adjustable from 400 kc to 25 mc per one screen diameter (horizontal expansion to 20 kc per inch)

Input Impedance: 50 ohms—nominal
Overall Gain: 120 db
Input Power: 400 Watts
Sensitivity: (minimum discernible signal)
STU-1: 10-400 mcs—89 dbm
400-1,000 mcs—84 dbm
STU-2A: 910-2,200 mcs—87 dbm
1,980-4,560 mcs—77 dbm
STU-3A: 4,370-10,920 mcs—75 dbm
8,900-22,000 mcs—60 dbm
STU-4: 21,000-33,000 mcs—55 dbm
STU-5: 33,000-44.000 mcs—45 dbm
Attenuation:
RF internal 100 db continuously variable (STU-1, STU-2A, STU-3A)
IF 60 db continuously variable

Frequency differences as small as 40 kc measurable by means of variable frequency marker with adjustable amplitude.
Portable and completely self-contained.

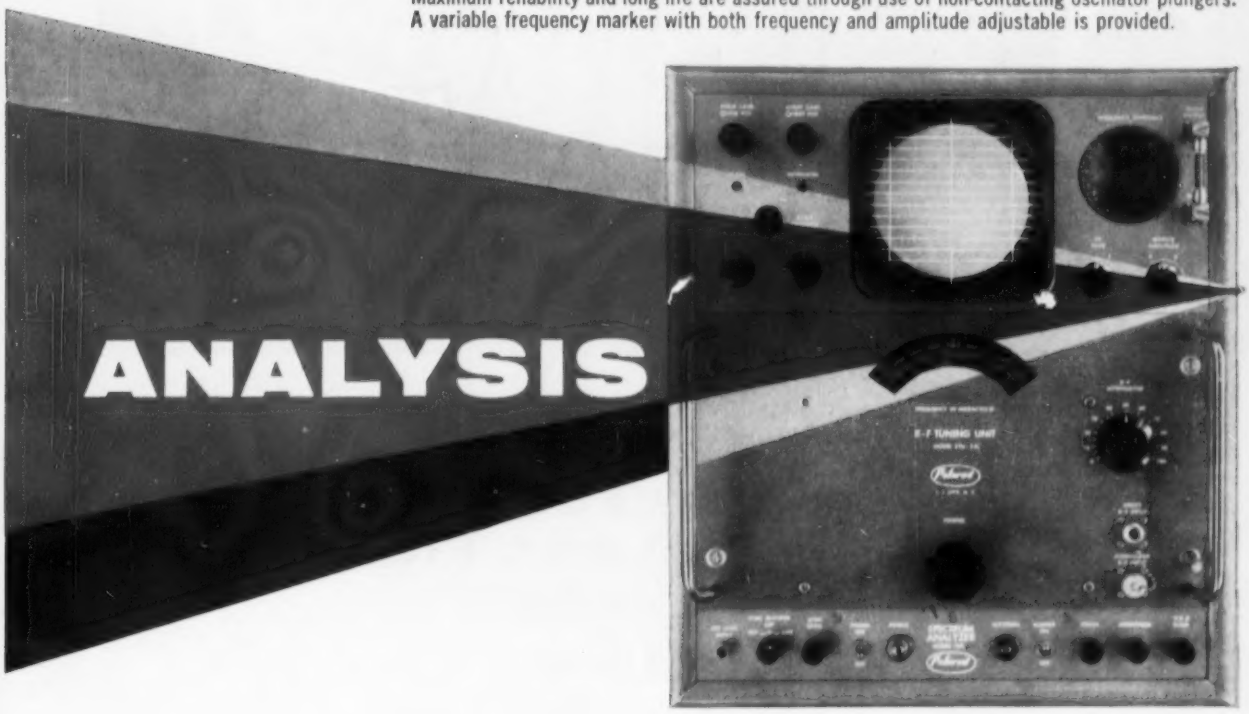
Want more information? Use post card on last page.

Broadband 10-44,000 mc

Now, the Polarad Model TSA Spectrum Analyzer provides the same visual advantages for microwave testing as the standard oscilloscope accomplishes for low frequency signals. This is a "must" instrument for microwave work! It displays with high sensitivity on a bright easily defined CRT, pulse modulation components, frequency differences, attenuation and band width characteristics, leakage detection, radiation and interference signals, and VSWR information.

This is visual instrumentation—it provides immediate and complete information because of the high resolution obtainable.

Frequencies are read directly on the linear dial with 1% accuracy as the set is tuned. Maximum reliability and long life are assured through use of non-contacting oscillator plungers. A variable frequency marker with both frequency and amplitude adjustable is provided.



Write today—directly to Polarad, or your nearest Polarad representative—to find out how the Model TSA Spectrum Analyzer can speed your research and solve your microwave measurement and testing problems.

Write for your copy of the Polarad "Handbook of Spectrum Analyzer Techniques". 50c per copy. Includes discussion of Spectrum Analyzer operation, applications and formulae for analysis techniques.

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TEFLON GLASS FIBER LACING

Ben-Har Braided TAPES

New Ben-Har Braided lacing and winding tapes combine two superior insulation materials . . . duPont Teflon and glass fibers. Teflon, with its high heat resistance of 500°F. has been coated directly on the glass fibers before braiding so as to preserve a rough texture for knottability while eliminating the abrasive action of the glass.

Developed particularly for harnessing, lacing and winding applications where heat is a determining factor, Ben-Har offers these additional features:

- non-shrinking — will not cut through insulated wires.
- pliable through −100°F. to 500°F.
- wax-free — fungus proof.
- inert to most known chemicals and oils.
- non-absorbent.
- knots hold tight, won't slip.

Ben-Har Braided Tapes are available in .048, .062, .090 and .22 inch widths; in natural color (offwhite); in 250 and 500 yard spools and a Universal wound ¼ pound tube. Brown, white, yellow, orange, red, green, blue, violet and black can be had on special order. Write for prices and samples.

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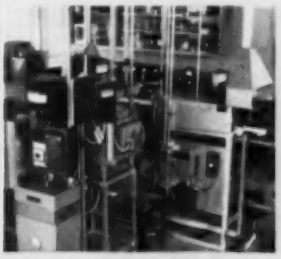
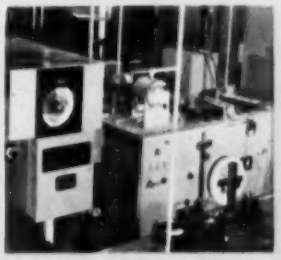
better quality through more advanced research and testing!

Behind every Ohmite component is a bulwark of *advanced* research and testing laboratories. These laboratories use the finest scientific instruments and equipment. Here Ohmite products are tested and retested under the most grueling conditions to detect possible sources of trouble. And these same laboratories are used for the development of new materials, new processes, and new designs . . . to build *reliability* into Ohmite products that set new standards for long life and trouble-free performance.



High temperature globar furnace; muffle furnace for enamel testing; hydrogen atmosphere sintering furnace.



Humidity chambers using program-controlled cycles; here Ohmite products are tested under a wide range of temperature and humidity conditions.

Microscopic and petrographic equipment used in Ohmite laboratories for optical examination of materials and products.

Microscopic analysis of structure using metallograph. Thermal expansion of ceramics and vitreous enamels can be determined with interferometer equipment.

Instruments shown above are used to check and standardize the many pieces of Ohmite electrical test equipment.

This power panel provides AC or DC in a wide range of currents, voltages, and frequencies . . . permits testing Ohmite products under operating conditions.

X-ray Diffractometer and X-ray Fluorescence Spectrometer make possible the determination of crystal structure, as well as elemental composition of materials and products by means of X rays.

Be Right with..

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RHEOSTATS • RESISTORS • RELAYS
TAP SWITCHES • TANTALUM CAPACITORS

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3610 Howard Street, Skokie, Illinois

build reliability into your product with OHMITE® COMPONENTS

close-control RHEOSTATS

All-ceramic and metal, close-control rheostats for unsurpassed dependability and smoothness of operation. Ten stock sizes, 25 to 1,000 watts.

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A wide range of dependable, fixed, adjustable, tapped, and noninductive power wire-wound resistors. Also a wide range of precision resistors.

general-purpose RELAYS

65 Types in four stock models. Good delivery on made-to-order relays. Contact current ratings up to 25 amps, AC or DC. Wide variety of contact arrangements. Hermetically sealed or dust-protective enclosures available.

high-current TAP SWITCHES

Five compact models, up to 100 amperes, AC, up to 12 taps. All-ceramic and metal construction. Silver-to-silver contacts, with self-cleaning rotor contact.

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Single layer R.F. plate chokes and power line chokes on steatite or plastic cores. Protected by a special moisture-resistant coating.

WRITE on Company Letterhead for Catalog and Engineering Manual.

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RELIABILITY...ACCURACY... AUTOMATIC MEASUREMENT AT NEW LOW COST

Available in either portable (shown) or rack mount models

ALL DESIGN FEATURES of higher priced NLS instruments now are available in the low cost Model 351 Digital Voltmeter for applications requiring 3-digit measurement. This economical model offers the *same range* as the *widely-used* NLS Model 451 (4-digit), recognized standard of the industry. It has the same exclusive NLS *oil-sealed* stepping switch system that guarantees maximum trouble-free life. Its performance offers *automatic measurement* from zero to ±999 volts d-c with high accuracy and resolution. And it has automatic polarity indication, automatic range selection, automatic readout decimal point location. *Fast readings* are flashed in brilliant in-line luminous numerical display. NLS Model 351 Digital Voltmeters *cost only $985.* Investigate today.

CHARACTERISTICS

RANGE	RESOLUTION
Zero to ±.999 volts d-c	±1 millivolt d-c
± 1.00 to ± 9.99 volts d-c	±10 millivolts d-c
± 10.0 to ± 99.9 volts d-c	±100 millivolts d-c
±100 to ±999 volts d-c	±1 volt d-c

ACCURACY: *Equal to resolution*

READING TIME: *0.80 seconds average.*

CHOPPER SAMPLING RATE: *60 cycles per second.*

INPUT IMPEDANCE: *1000 megohms on zero to .999 volt scale; 10 megohms on all other ranges.*

CALIBRATION VOLTAGE: *Standard cell provides EMF constant within ±0.01% from 4°C to 50°C, and usable from −16°C to +60°C, with accuracy of ±.02%.*

REFERENCE VOLTAGE SOURCE: *Internally-mounted mercury cell.*

POLARITY INDICATION: *"+" or "−" automatically prefixes the numerical display.*

READOUT DECIMAL POINT: *Positioned automatically depending on range.*

STYLES: *Rack mount – 5¼" high; 19" wide; 15⅛" deep. Portable—11" high; 8¼" wide; 15⅛" deep.*

WEIGHT: *Only 29 pounds (new, lightweight aluminum construction).*

POWER: *115 ± 10 volts, 60 cycles, 75 watts.*

OPTIONAL ACCESSORIES:
Remote readouts with cables.
Manual-command recording controls.
Automatic recording controls to record each reading at completion of balance.

non-linear systems, inc.

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ORIGINATORS OF THE DIGITAL VOLTMETER

Digital Ohmmeters • AC-DC Converters • Data Reduction Systems • Digital Readouts • Peak Reader Systems • Binary Decimal Converters Digital Recording Systems

NON-LINEAR SYSTEMS, INC.
Dept. B-116, Del Mar Airport, Del Mar, Calif.
Send new Technical Bulletin 856 with full information on NLS Model 351 Digital Voltmeter.

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If it's worth engineers' time...

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ELECTRONIC WIRE

The complete packaged line—easy to use. Be sure of the right wire engineered for the job.

There are 1001 Belden wires for every Radio and Electronic requirement.

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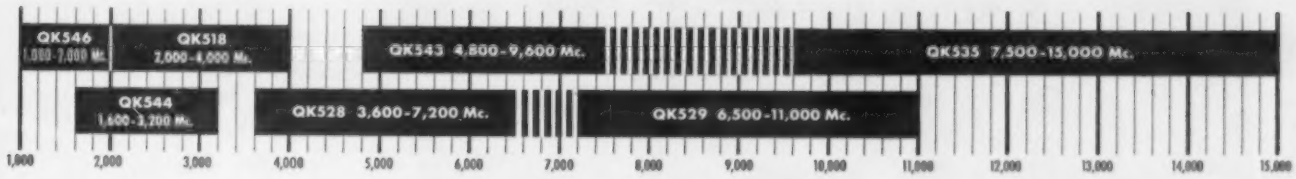
VOLTAGE TUNABLE



QK518 specifications

Frequency: 2,000-4,000 Mc.

Rapid electronic tuning by varying delay line voltage from 150-1,500 Volts.

Power output: 0.1 to 1 watt.

Complete with compact permanent magnet.

Approximate maximum dimensions: 10" long, 4⅜" high, 4⅞" wide.

NEW Raytheon Backward Wave Oscillator Series

for wide, rapid electronic tuning—1,000 Mc. to 15,000 Mc.

The tubes in this revolutionary new line of Raytheon Backward Wave Oscillators give you four outstanding performance advantages:

1. Electronically tunable over an *extremely* wide range of frequencies
2. Frequency insensitive to load variations
3. High signal-to-noise ratio
4. Can be operated under conditions of amplitude or pulse modulation

These new tubes are finding fast-growing applications in microwave equipment, including radar and signal generators.

Write today for free Data Sheets on this series of Backward Wave Oscillators. We'll also be happy to answer any questions you may have on this new line.

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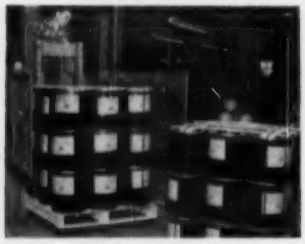
Raytheon makes: Magnetrons and Klystrons, Backward Wave Oscillators, Traveling Wave Tubes, Storage Tubes, Power Tubes, Receiving Tubes, Picture Tubes, Transistors

Minneapolis Honeywell finds.....

At Minneapolis-Honeywell, ReaPak Pails — holding 100 pounds of continuous length wire — replace the conventional spools holding only ten to fifteen pounds.

ReaPak is fully adaptable to multiple winding in your plant.

ReaPak is adaptable to single head winding.



ReaPak can be palatized. Another way ReaPak can save you storage space, handling time and cost.

ReaPak can replace 8 to 50 reels or spools. This means faster reloading, less down time.

HERE'S HOW REAPAK COULD FIT YOUR OPERATION

If you wind coils of any type, or are a user of magnet wire of any size from AWG 10 to 30, you will find that ReaPak can help you reduce your costs of production in many ways.

ReaPak gives you up to 500 pounds of continuous length wire. That means you will have less down time for reloading. What's more, because ReaPak gives you longer continuous lengths of usable wire, you'll have fewer "unused ends!"

You can order ReaPak in your choice of insulations. Wire sizes: AWG 10 to 30.

ReaPak containers also give excellent protection during storage, shipping and handling. No small spools for operators to drop and damage.

If you use magnet wire, ReaPak can fit your operation!

Want more information? Use post card on last page.

.... REAPAK® cuts reloading time by 90%

Using REAPAK... the magnet wire that comes in pails... the world's largest Automatic Control Manufacturer:

- **INCREASED COIL PRODUCTION 18%**
- **SAVED $19,000 PER YEAR ON WIRE COSTS**
- **VIRTUALLY ELIMINATED END-OF-SPOOL WIRE WASTE**
- **CUT RELOADING TIME PER DAY FROM 1½ HOURS TO LESS THAN 10 MINUTES**

Minneapolis-Honeywell uses two and one-half tons of wire daily in winding its precision electrical coils for relays, transformers, motors, thermostats and other electrical devices. Before ReaPak, operators handled sixty to seventy spools of wire (each weighing from five to fifteen pounds) every day. Time lost in reloading: 1½ hours daily per operator.

By switching to ReaPak (a continuous length of magnet wire, packaged in pails for high speed dereeling) Minneapolis-Honeywell cut the daily down time needed for reloading and adjustment of wire tension to less than ten minutes.

Wire waste was cut, too. Operators using ReaPak waste less than five feet of wire per pail. This, and other savings made possible by the ReaPak method, enable Minneapolis-Honeywell to save $19,000 per year. No wonder they have adopted wire in steel pails for all of their coil-winding operations!

Because operators spent less time changing spools and adjusting wire tension, production per machine has increased from 270 to 320 coils per hour.

Company officials say the switch to ReaPak has meant an additional saving of $2,500 annually in handling and shipping. Empty spools and reels no longer must be returned because ReaPak Magnet Wire comes in disposable metal pails.

One of the first major users of magnet wire to see the advantages of ReaPak, Minneapolis-Honeywell officials are convinced ReaPak will be of even greater value in the near future.

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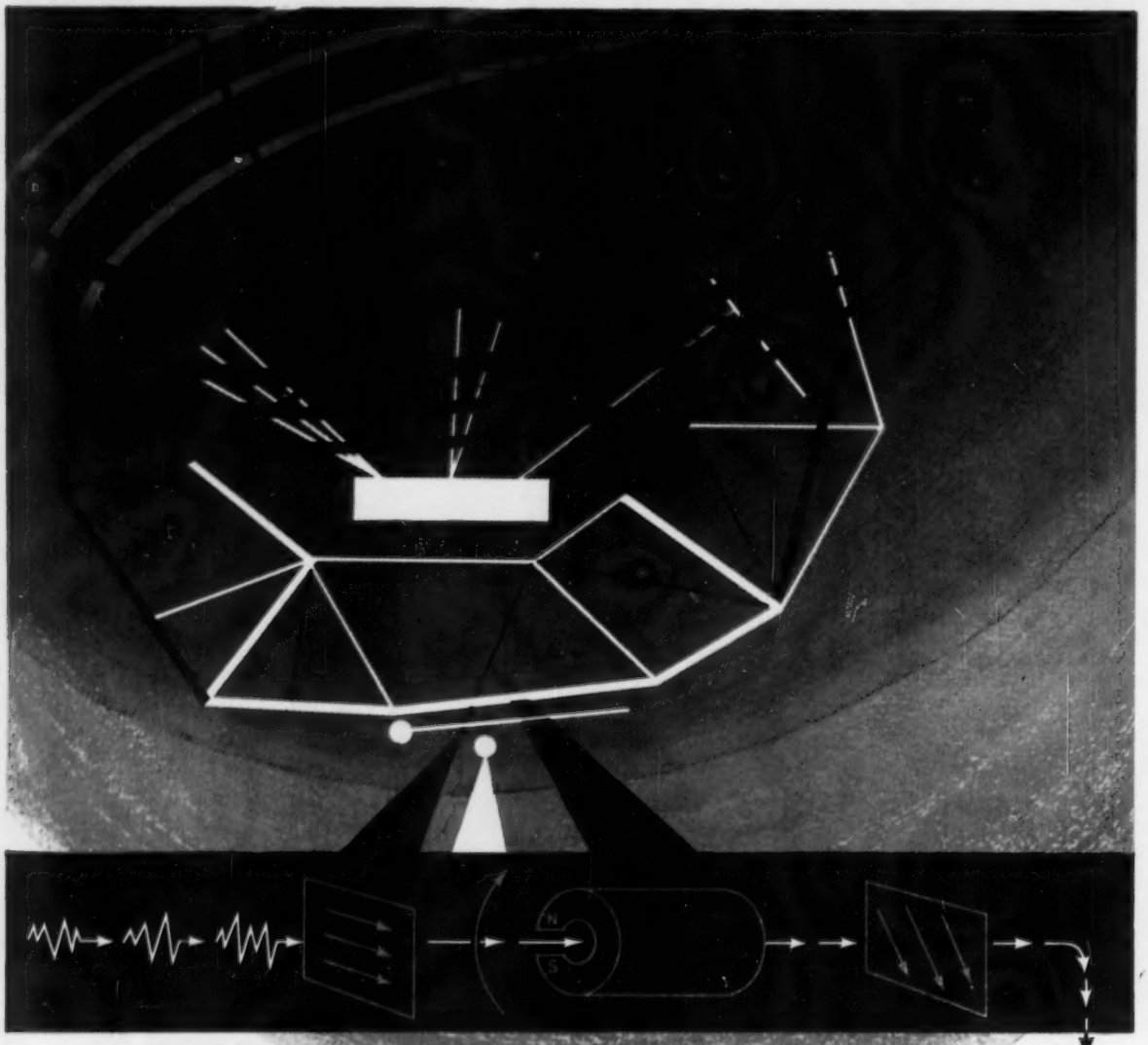

in radar load isolators, too

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Special applications, such as radar load isolators, demand compact but powerful magnet assemblies. And this is but one of the many places where the *consistently* higher energy product provided in Crucible Alnico magnets pays off.

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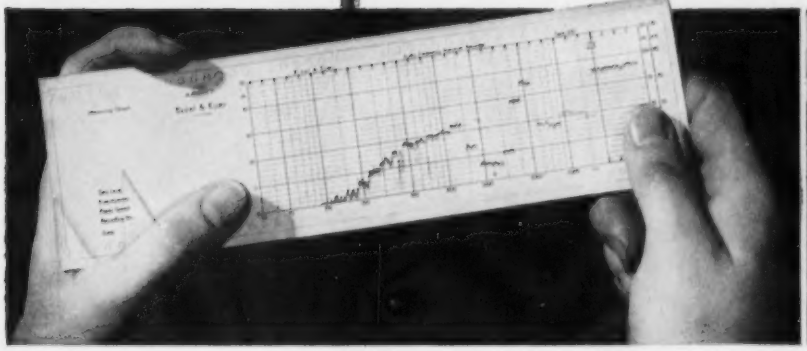

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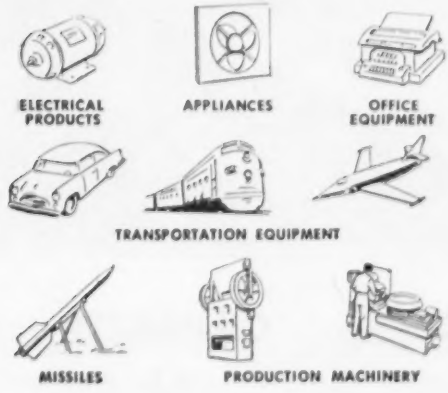

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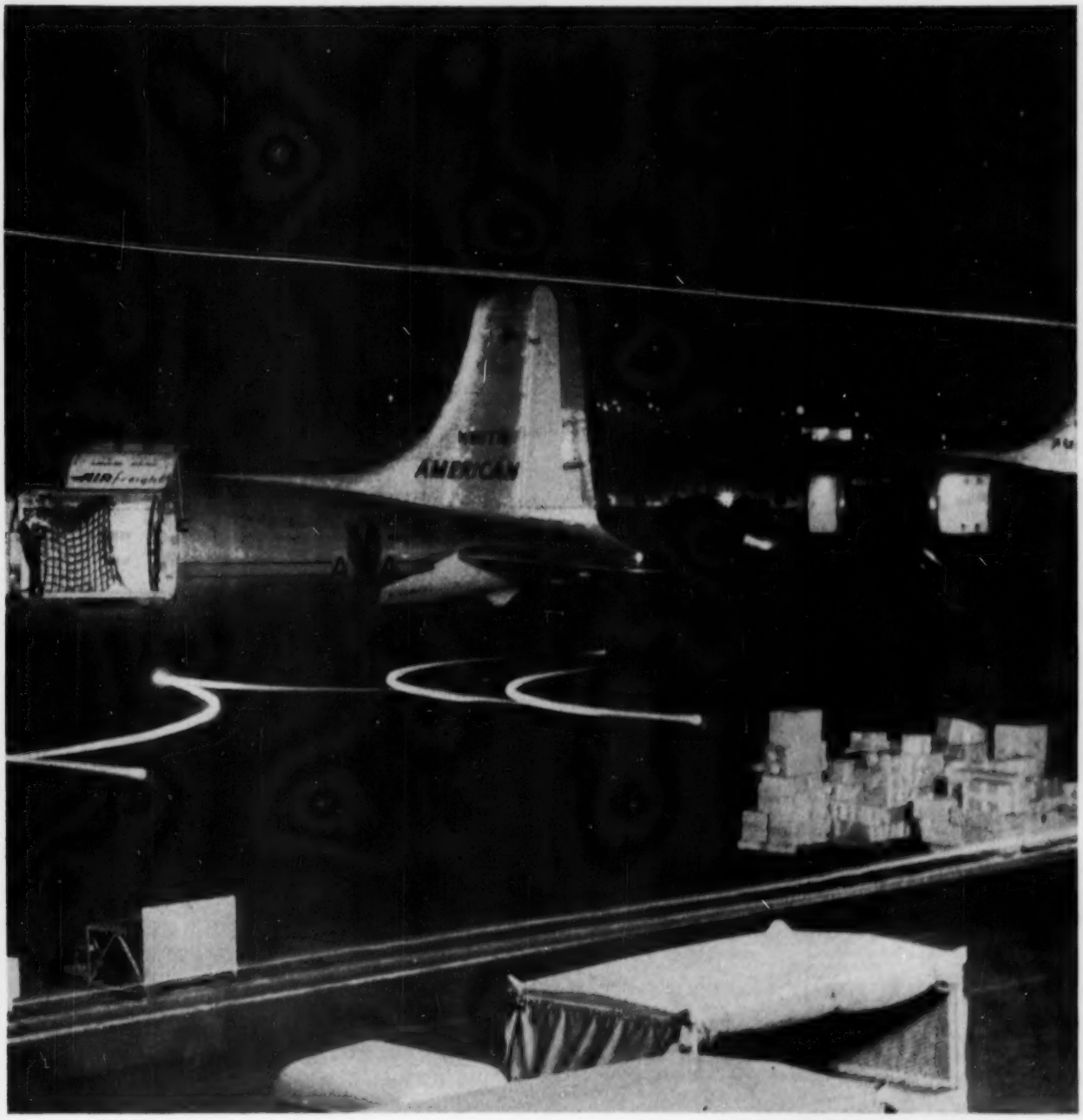

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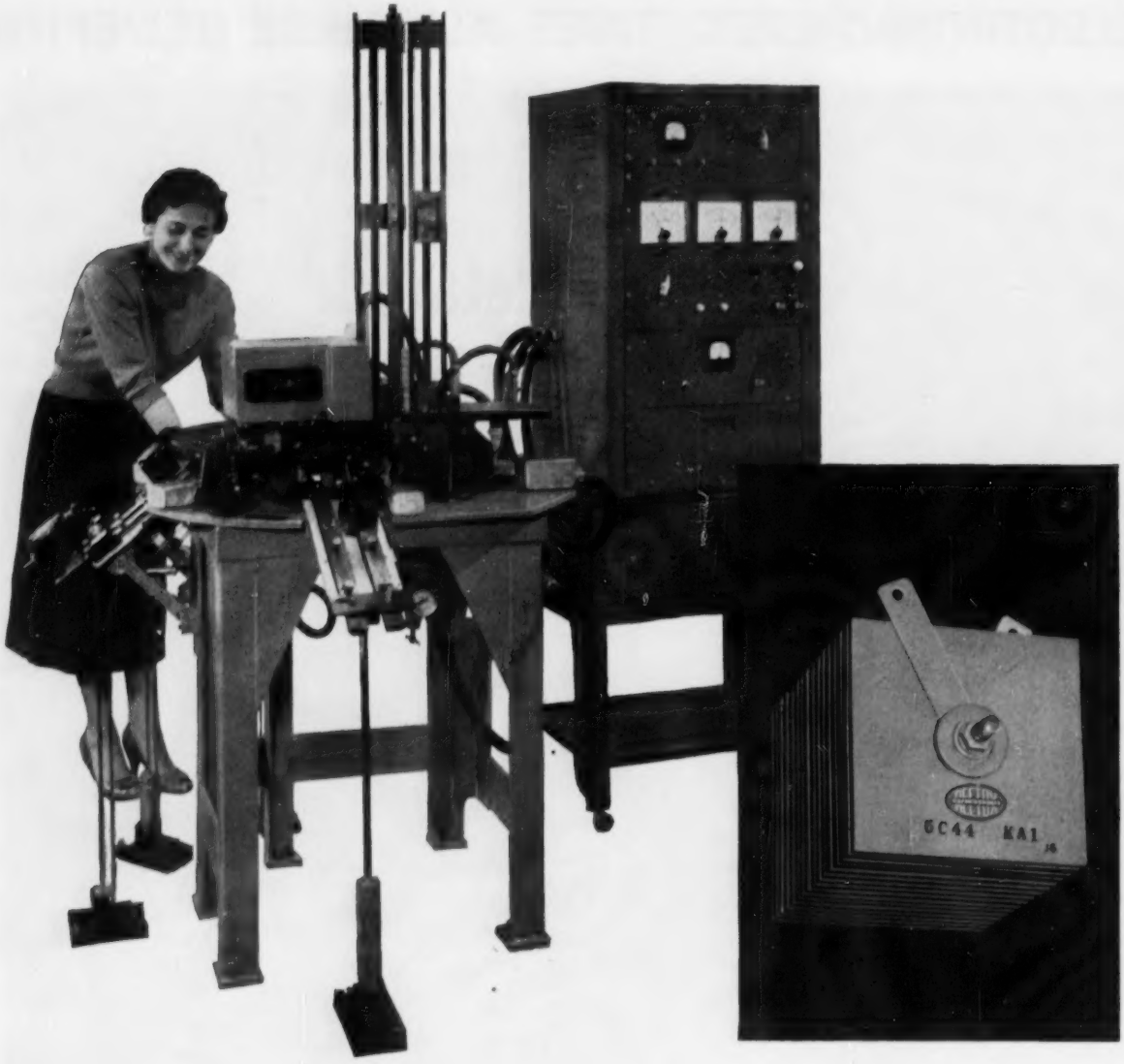

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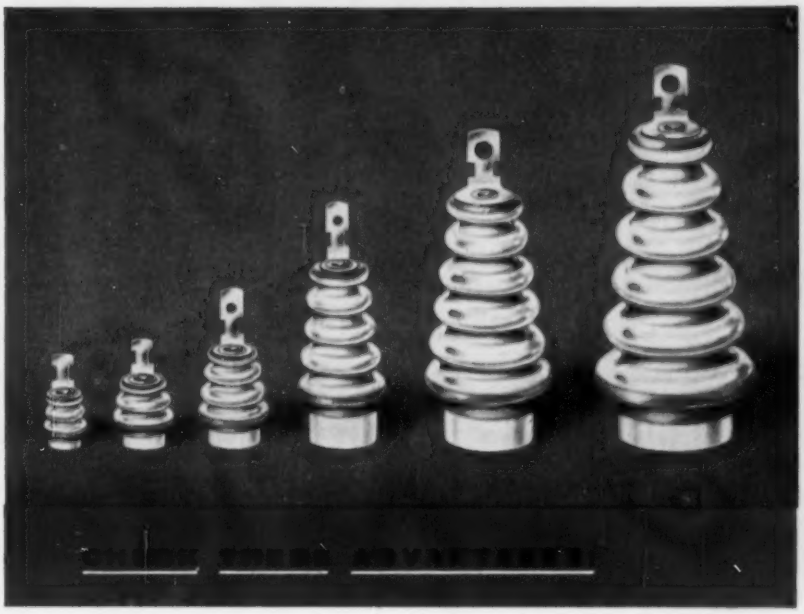

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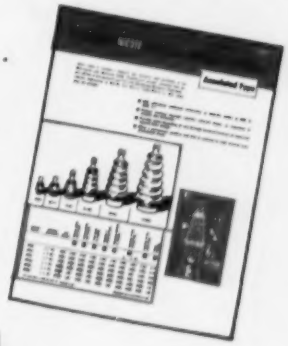

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*C. L. Cowan, Jr., F. Reines, F. B. Harrison, H. W. Kruse, A. D. McGuire, *Science* 124, 103 (1956)

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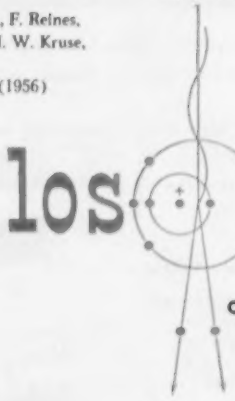

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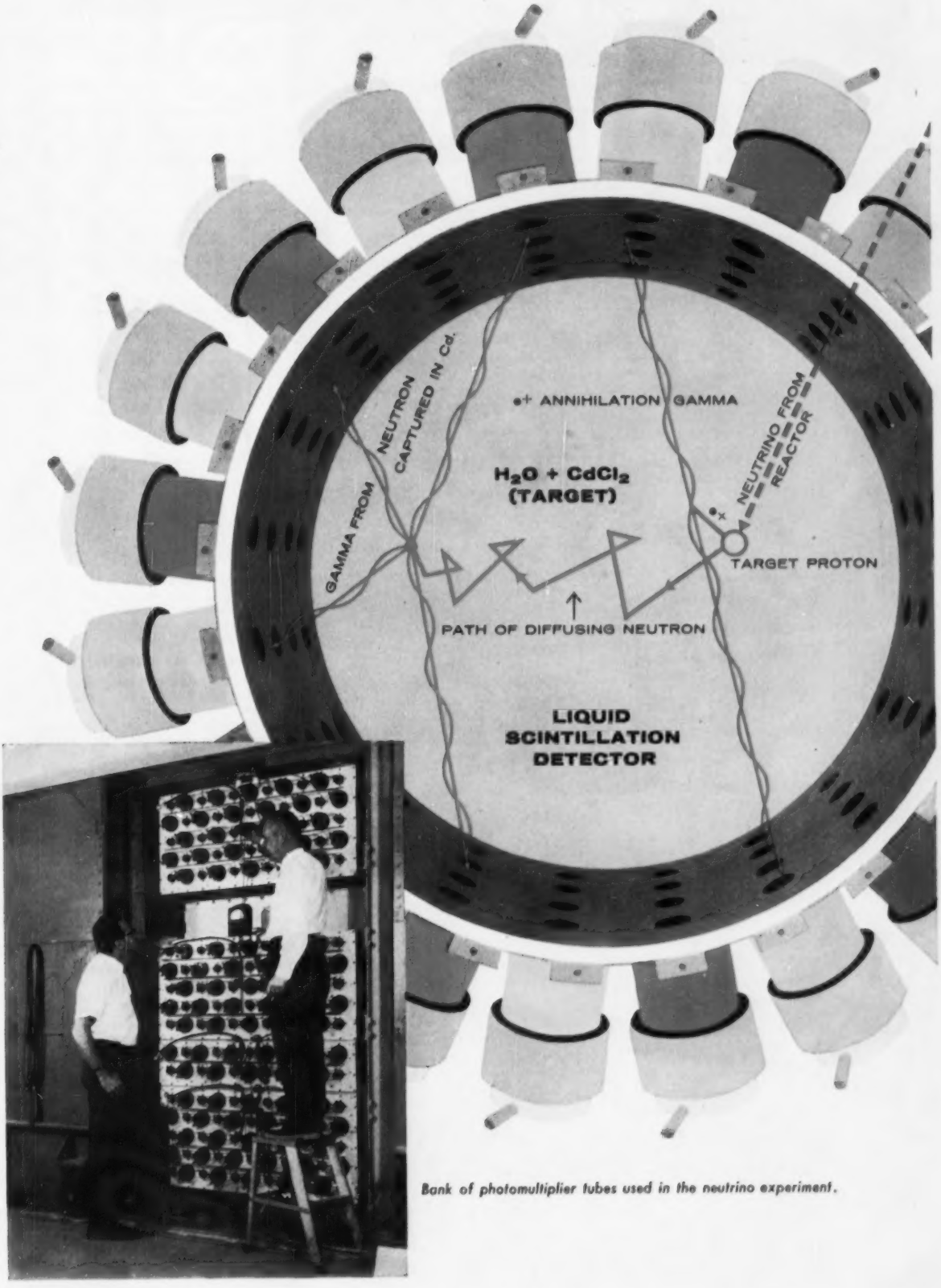


Bank of photomultiplier tubes used in the neutrino experiment.

ENGINEERING BULLETIN

ON MICRO-BEARINGS

Miniature Instrument Ball Bearings

NEW HAMPSHIRE BALL BEARINGS, INC.

PETERBOROUGH 1, NEW HAMPSHIRE

Subject: **RADIAL AND AXIAL PLAY**

This bulletin explains the interrelation between radial play, axial play and contact angle in small instrument type ball bearings, and assists in specifying these characteristics correctly for typical applications.

DEFINITIONS

Radial play is the maximum possible radial displacement of the inner ring with respect to the outer ring when the bearing is unmounted. *Axial play* is the maximum possible axial displacement of the inner ring with respect to the outer ring when the bearing is unmounted. *Contact angle* is defined as the angle between a plane perpendicular to the bearing axis and a line connecting the two points on a given ball where it makes contact with the raceways under a condition of pure thrust load.

Radial play, axial play and contact angle are geometrically interrelated, but since radial play is the most readily measurable, it is the characteristic usually specified.

In *Fig. 1*, values of axial play resulting from a given radial play and ball size, are given for reference purposes.

SPECIFYING RADIAL PLAY

Two fundamental considerations must be established before arriving at a correct radial play specification: (1) the direction of the load imposed on the bearing, and (2) the axial play control, if necessary for the proper functioning of the unit. This is ultimately a problem of considering the contact angle resulting from a given radial play. High radial play is associated with high contact angle. This relationship is illustrated on *Fig. 2*.

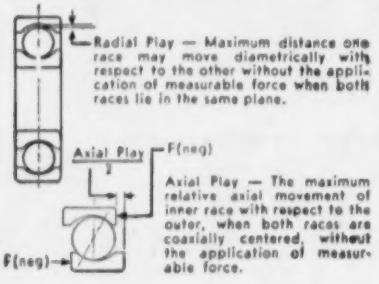
TYPE OF LOAD

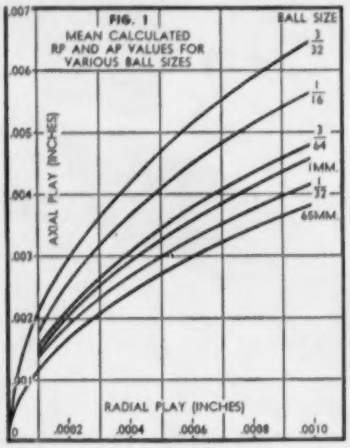
If there is a measurable *axial load*, such as is encountered with bevel gearing, or in an application such as illustrated in *Fig. 3*, the bearings should operate at a high contact angle. Under such circumstances, a radial play of .0005 to .0008 is recommended.

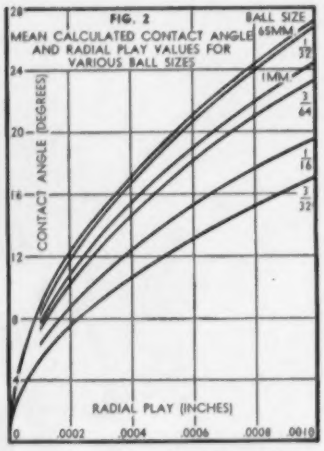
If the application involves a *pure radial load*, such as in the case of spur gears *(Fig. 4)*, there is no concern with contact angle, since it will be zero.

LOW RADIAL PLAY

Functional requirements of the application will dictate whether the radial play is low or standard. However, before *low* radial play is specified, the following factors must be considered:


Radial Play — Maximum distance one race may move diametrically with respect to the other without the application of measurable force when both races lie in the same plane.
Axial Play
F(neg)
Axial Play — The maximum relative axial movement of inner race with respect to the outer, when both races are coaxially centered, without the application of measurable force.
F(neg)





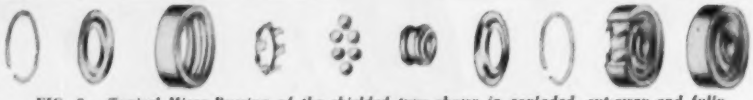


FIG. 5. *Typical Micro-Bearing of the shielded type shown in exploded, cut-away and fully assembled views.*

1. *A bearing with low radial play should not be subjected to interference fitting. This causes reduction in radial play which may create excessive preload resulting in early bearing failure.*
2. *Low radial play results in a low allowable angle of misalignment. An important feature of a ball bearing is its ability to adjust itself internally to possible housing misalignment, particularly when through-boring is not possible.*

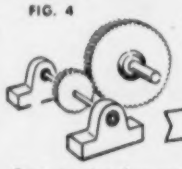
There is one situation, however, where low radial play is recommended. If the bearing is to be subjected to very high repetitious radial shock loads, low radial play minimizes the possibility of bearing damage by distributing the load over a greater number of balls.

AXIAL PLAY CONTROL

If a design calls for axial play values of .002 or less and the bearings are to be used to limit axial travel, it is *not* good practice to achieve this by specifying low radial play. The design should provide for external means of adjustment such as shims. For such cases, the recommended radial play is from .0005 to .0008.

Great care should be exercised if any means other than a calibrated spring is employed to take out *all* axial play. Preloading, with its many complications, may result. Zero axial play automatically yields zero radial play. A high radial play, such as .0005 to .0008, is recommended in cases where axial play is to be reduced to zero by external means.

FIG. 4



Weather vane bearing carries purely thrust load and normally involves high contact angle and high radial play.

Spur gear bearings carry a purely radial load where contact angle is zero.

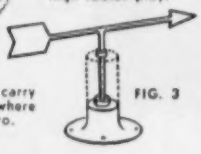


FIG. 3

RADIAL PLAY SPECIFICATION

There is a misconception among many bearing users that radial play is automatically considered under the ABEC classification. Such is not the case.

However, standard "MICRO" bearings are assembled with a radial play of not less than .0002 nor greater than .0008, unless so ordered. If this range of .0002 to .0008 is acceptable in the application, it is recommended that *No Radial Play Specification* be placed on the bearing.

Radial play is specified most conveniently by a tolerance range. Thus, while the radial play of a given bearing might be .00036, it is more convenient to represent this value as .0002 to .0005. Detailed instructions for specifying other than standard radial play values are incorporated in our catalog.

Since radial play is determined during the bearing manufacturing, specifications of other than standard values should be considered carefully at the design stage, as it may result in delay in assembly and delivery.

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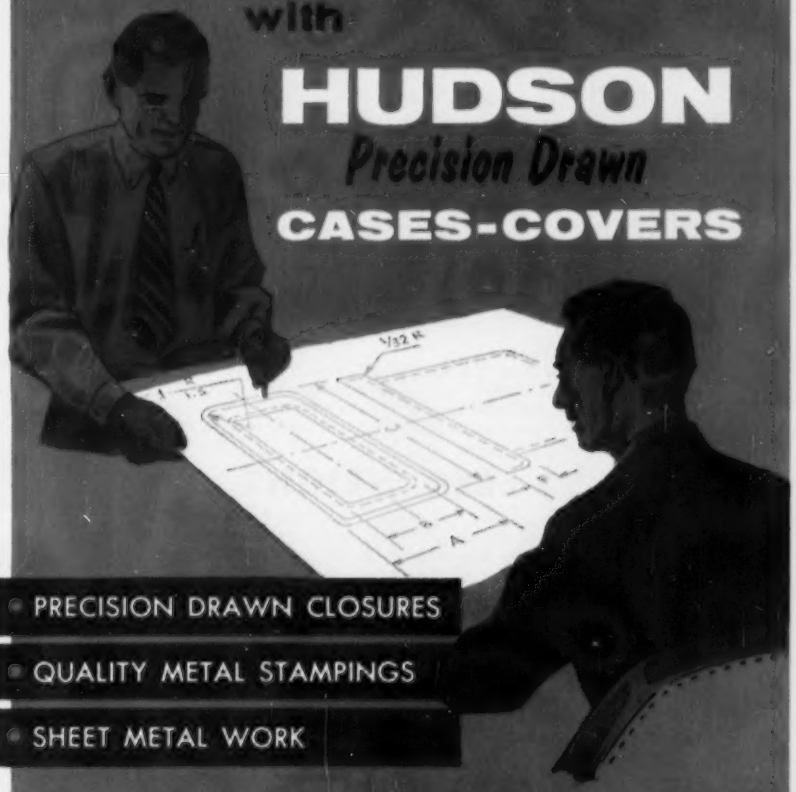

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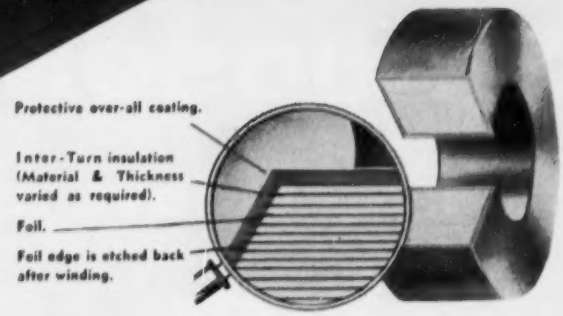
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Case Style (Illustrated at Right)	TYPE DESIGNATIONS			
	Paper Dielectric		Mylar* Dielectric	
	Type No.	Application Notes	Type No.	Application Notes
A	503PM 522PM	Paper dielectric designs are in most common use for general purpose applications. Types in the 503 "Marbelite" series are impregnated with solid plastic. Types in the 522 "Miracle X" series are oil impregnated.	620PM	Mylar dielectric is most often used where small physical size is essential. Also important, however, are such properties as high IR, low power factor, and stability with life.
B	503PS 522PS		620PS	
C	503E		600UPE	
D	503PB 522PB		620PB	
E	503PBK 522PBK		620PBK	
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*Du Pont's trade mark for their Polyester Film.

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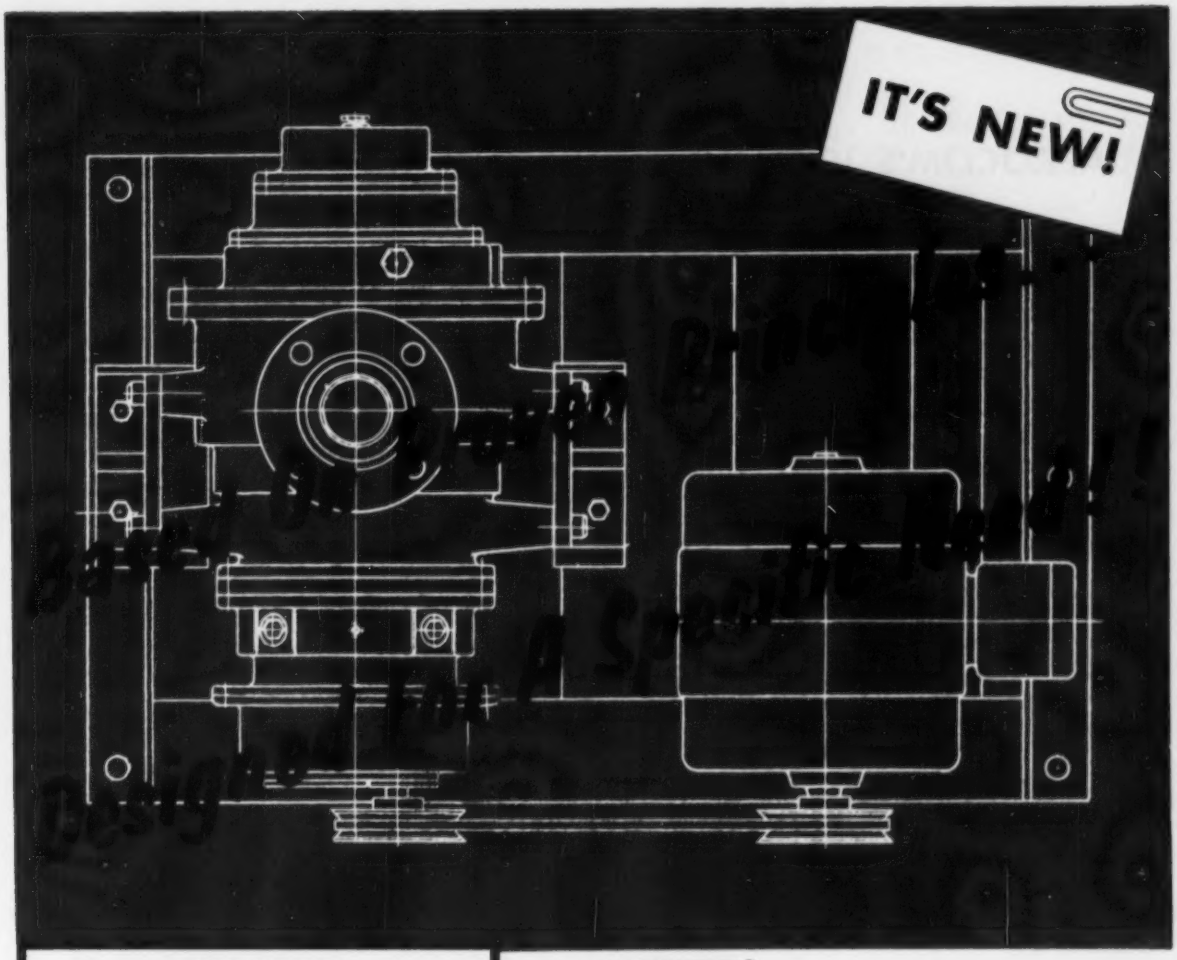

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Free Air Displacement	30 CFM
Free Air Displacement	14.2 liters/sec.
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- Please send complete data on the new Kinney Model KMB-30 Mechanical Booster Vacuum Pump.

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AEROCOM'S 1046 H. F. TRANSMITTER

POWER + STABILITY

1000 WATTS WITH .003% STABILITY

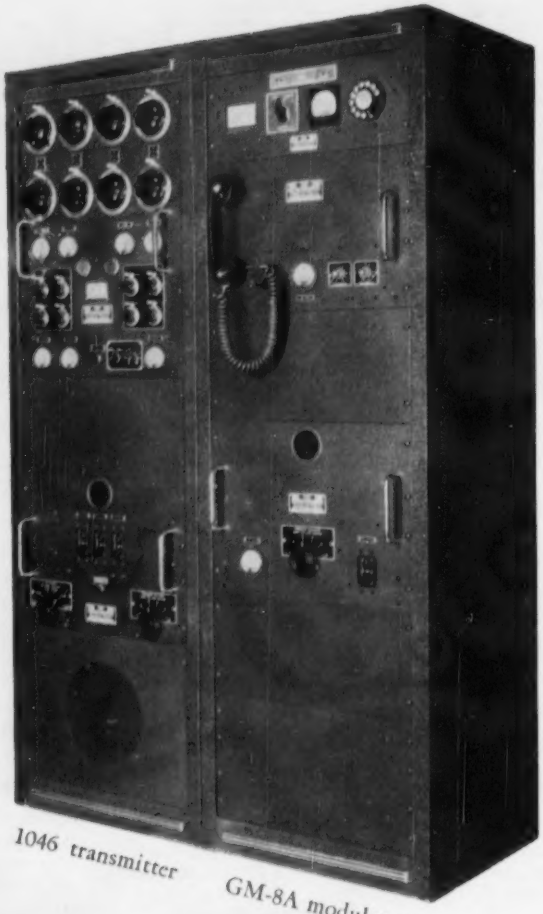
Rugged, versatile general purpose H. F. transmitter—Aerocom's 1046 packs 1000 watts of power and high .003% stability under normal operating conditions (0° to +50° C.). Excellent for point-to-point or ground-to-air communications.

Multi-channel operation on telegraph A1, or telephone A3 with GM-8A modulator... new Aerocom 1046 can be *remotely controlled* with TMC-R at control position and uses only one pair of telephone lines. In A3 operation, the local dial control panel is located in modulator cabinet.

Transmitter cabinet has 8¾ inch panel space available for either local dial control panel or frequency shift keyer.

Model 1046 operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.0—24 Mcs. Operates on one frequency at a time; channeling time 2 seconds. Operates into either balanced or unbalanced loads. Operates in ambient -35° to+50° C. Power supply: nominal 220 volts, 50-60 cycles, single phase.

Complete technical data on request



1046 transmitter GM-8A modulator

Now! Complete - package, lightweight airborne communications equipment by Aer-O-Com! Write us today for details!

AER -O- COM

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New Grant 3400 *thinslide*

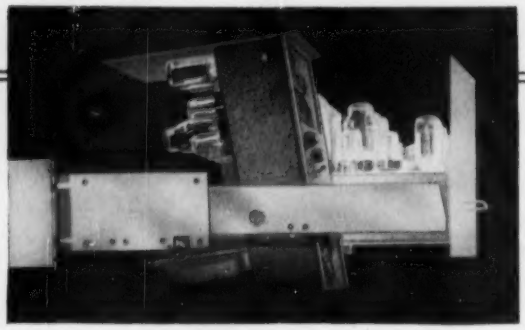
mounts standard 17" chassis in standard 18" rack or cabinets

REQUIRES ONLY 19/64" SPACE PER SIDE—

YET HAS

FULL ROLLER ACTION

(fits RETMA *rack hole spacing)*



The Grant 3400 Thinslide requires only 19/64" space per side—installs readily in standard racks and cabinets. Allows instant access to chassis measuring from 10" to 16" deep. Tilts through 100° for under-chassis servicing. Positive lock in "out" position. Lock has finger-tip release for instant return or removal of chassis. Eight hardened steel rollers carry the rated load of 100 lbs. smoothly and easily—durability insures frictionless rolling for thousands of cycles of use.

Slide mounting not only provides for quick access—it usually eliminates need for rear access doors and rear aisles—a very important saving of space.

The Grant 3400 is a versatile slide, suited for use in your *product*, in *plant equipment*, *prototype* and *breadboard* work, and in *production line or field test equipment*. Very moderate cost allows a wide range of applications in original equipment.

Write today for Grant 3400 Thinslide Technical Bulletin—contains full data and specifications.

Grant INDUSTRIAL SLIDES

Grant Pulley and Hardware Corporation

factories: **31-73 Whitestone Parkway, Flushing 54, N. Y.**
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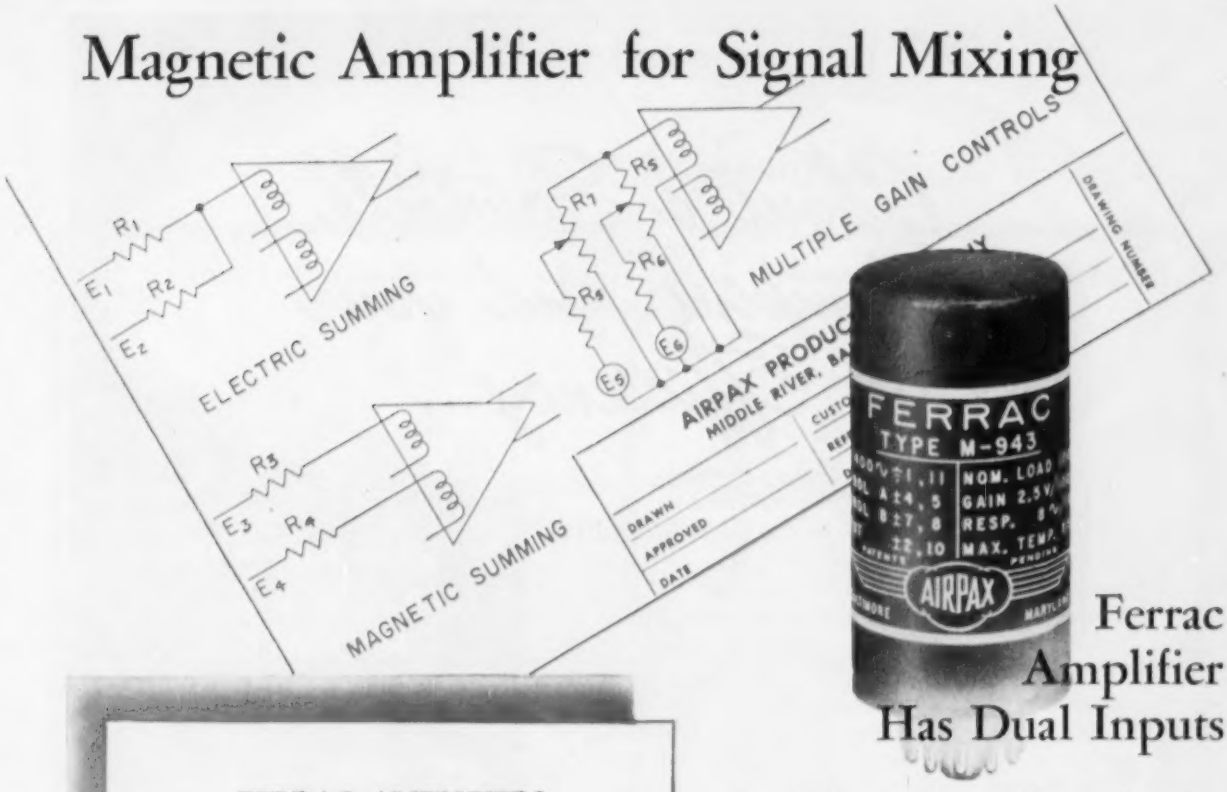
Magnetic Amplifier for Signal Mixing



Ferrac Amplifier Has Dual Inputs

Here is the magnetic amplifier you have been looking for. Its characteristics make it ideal for computing functions in analog controls. Basic to such computation is signal mixing or summing.

The schematic shows how a Ferrac amplifier can be used to sum several signals. For simplicity, the diagrams show two signals being mixed; more signals can be summed if necessary.

Either electric summing or magnetic summing can be used, or both can be used in combination. Electric summing mixes the signals through summing resistors connected to the amplifier input, one resistor for each signal. Magnetic summing mixes the signals through summing control coils in the magnetic amplifier, one control coil for each signal.

Magnetic summing is particularly flexible. The signals do not need a common ground; they can be isolated from each other. Multiplying coefficients are provided by resistors in series with the control coils of the amplifier; these resistors can be made variable to change the coefficients in accordance with changing control condition.

Would you like to know more about this versatile Ferrac magnetic amplifier? Simply write us.

FERRAC AMPLIFIERS

INPUT: Two fully isolated control coils. DC polarity reversible.

OUTPUT: Unfiltered DC, polarity reversible linear ± 7.5 DC volts into a 1000 ohm load.

GAIN: Typical gain gradients of Ferrac amplifier are 2.5 volts output per 100 μa input, 0.5 V/100 μa, and 10 V/100 μa. Under standard conditions, the gain of any Ferrac amplifier is within ± 1 db of its nominal value and within ± 2 db under environmental conditions.

POWER REQUIREMENT: 115 volts at 400 CPS ± 10% in voltage or frequency; approximately 1.5 watts for standby and 2.5 watts at maximum output.

ENVIRONMENT: —55 C to +85 C operating, withstands 10 G vibration from 10 to 55 CPS in any position for 1 hour and 30 G shock of 11 ± 1 millisecond duration in any position, is hermetically sealed.

AIRPAX
DESIGNERS ENGINEERS

MIDDLE RIVER BALTIMORE 20, MD.

Want more information? Use post card on last page.

About a Sawtooth, Clamping and your Efficiency...

Let's look at it this way—What features should an instrument incorporate to make your job easier, help prevent costly mistakes? Take the case of the new PRD Klystron Power Supply. Should we incorporate a sawtooth rather than a sine wave modulation? It's easier to put in a sine wave. However, a sawtooth has the definite advantage of eliminating phasing and blanking problems when the frequency response of a transmission device is to be studied. So, in goes the sawtooth. It's easy enough to get hold of some sine wave modulation which can be applied through the external modulation input.

As for preventing mistakes—consider switching from cw to square wave modulation. Suppose you forget to readjust the reflector voltage . . . Sure, you'll catch the mistake later, but time is lost. The new PRD Klystron Power Supply has an electronic clamping circuit which locks the top of the square wave to the previously chosen reflector voltage. No readjustments to think about, no mistakes.

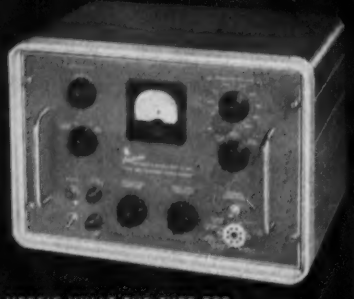
Want to modulate with pulses—use the external input. The rise time degradation of your pulses will be less than .1 microsecond!

Another point, good regulation! Here's an example: a ±10% line change or *any* load change will cause a reflector voltage change of only ±0.1%.

Compare . . . chances are that you'll send in your order for the PRD Type 809, too.

The New PRD

KLYSTRON POWER SUPPLY



HERE'S WHAT THE TYPE 809 CAN DO FOR YOU—

- Powers most low and medium voltage klystrons—up to 600 V. at 65 ma being supplied and reflector voltages up to −900 V.
- Has electronic readjustment of reflector voltage when changing from cw to square wave modulation—no errors due to forgetfulness
- Has variable square wave, **sawtooth** and provision for external modulation for pulses
- Affords exceptional stability and regulation at modest cost
- Price $350.00 F.O.B. New York

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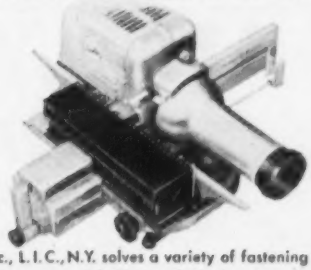
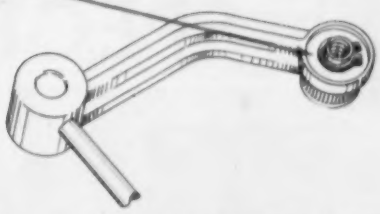
Waldes Truarc Rings Permit Better and More Economical Design—Fewer Parts, Faster Assembly, Minimal Rejects!

Viewlex's Change-O-Matic



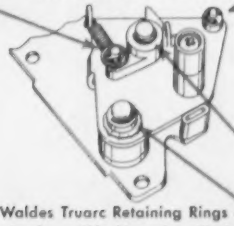
Viewlex, Inc., L.I.C., N.Y. solves a variety of fastening problems in their new model Change-O-Matic automatic slide changer. Assembly time is speeded, parts eliminated, rejects lowered, and compact, economical product design achieved.

Connecting Arm Assembly



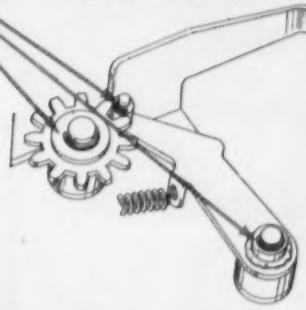
Use of one Waldes Truarc Ring (Series 5100) eliminates time-consuming riveting over the flange, retains and holds the connecting knob captive. A compact, neat design is made possible, rejects caused by poor riveting eliminated.

Actuating Plate and Pawl Assembly



Three types of Waldes Truarc Retaining Rings are used in this assembly. One circular self-locking ring (Series 5105) retains pawl return spring. One external E-ring (Series 5133) retains roller used to prevent gear motion during transport cycle. One crescent ring (Series 5103) retains pawl which indexes gear. Second crescent ring retains sub-assembly. Truarc Rings speed assembly, cut rejects, eliminate parts.

Detent Lever Assembly



Truarc E-ring (Series 5133) eliminates use of tapped hole and shoulder screw, retains roller which prevents over-travel of gear. Assembly is rapid.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!

Send for new catalog supplement

WALDES TRUARC® RETAINING RINGS

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Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

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E118

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

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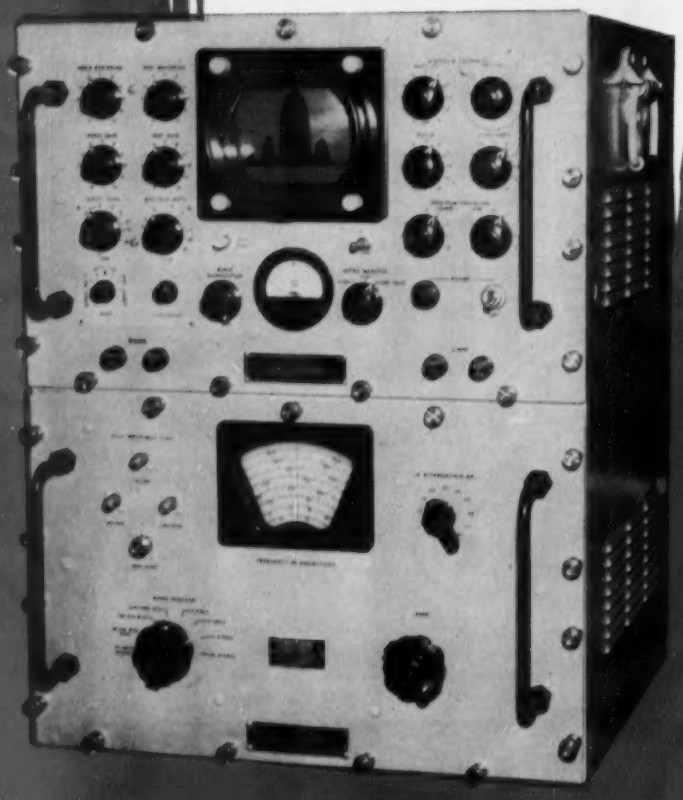
the LA-18



With these OUTSTANDING FEATURES

- Rock-stable oscillators permit observation even of signals with minor instability characteristics.
- Simplified band-switch arrangement permits coverage of entire 10MC to 32,000MC range in seconds.
- Wide-range sweep provides adequate display of even long-range radar spectra.
- Vernier marker pip provided for Δf measurements.
- "One-head" design absolutely precludes misplacing tuning units. NO SEPARATE TUNERS TO BUY.
- TRIPLE SHIELDING allows operation in powerful fields without spurious responses.
- Sensitivity better than —50 dbm (for 2/1 S/N) throughout most of X and K band.
- Battleship construction for dependable ruggedness without excessive weight. Removable subassemblies simplify servicing.

Extremely Versatile... Unusually Adaptable

Used with the Lavoie LA-61 Frequency Meter, the LA-18 can easily measure from 500MC to 35,000MC with .001% accuracy.

Used with the Lavoie LA-61 Frequency Meter and the LA-800 WWV Comparator, the LA-18 becomes the Model LA-670 Microwave Frequency Standard.

Send for brochure on the LA-18 and the name of our nearest engineer representative who will arrange a practical demonstration AT YOUR PLANT—to suit your convenience.

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- Research
- Development
- Manufacture

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GENERATORS

to your precise specifications.

MANUFACTURED UNDER CLOSE QUALITY CONTROL INCLUDING 100% ELECTRICAL INSPECTION.

TYPE GENERATOR	SIZE	OSTER TYPE	MOUNTING	LENGTH INCHES	MOTOR						GENERATOR				
					Power Supply	Min. Stall Torque oz-in	No Load Speed RPM	Take Watts Input at Stall	Rated Voltage Fixed Phase	Rated Voltage Control Phase	Output Voltage Gradient Volts 1000 RPM No Load	Linear Up To RPM	Excitation Voltage	Null Voltage Millivolts	Phase Shift
A.C. Tachometer	10	10-MTG 6227-01	Face	2-9/16	400~	.1	9,500	10	115	115	12.5 200~ at 6000RPM	—	—	—	—
Rate	10	10-MTG 6226-02	Syn-chro	2-9/64	400~	.3	6,500	—	26	26	.24	4500	26V 400~	23	—
Rate	10	10 6677-01	Face	1-3/8	Mech. Driven	—	—	—	—	—	.41	8000	18V 400~	50	—
Rate	10	10-MTG 6231-01	Syn-chro	2-3/16	400~	.26	19,400	14	26	26	.34	8000	26V 400~	23	7°
Rate	10	10-MTG 6226-04	Syn-chro	2-15/16	400~	.3	6,500	6.2	26	26	.45	4000	18V 400~	50	—
Rate	10	6229-03	Syn-chro	2-1/8	400~	.25	10,500	6.0	26	26	.3	4000	18V 400~	12	—
Rate	10	6229-02	Syn-chro	1-5/8	400~	.25	10,000	6.0	26	26	01-5.5 ø2 .115	4000	18V 400~	12	0-5°
Rate	10	6229-05	Face	2-1/8	400~	—	10,000	6.0	26	26	.3	4000	18V 400~	12	—
Tachometer Squirrel Cage Rotor	10	10-TG 6676-01	Syn-chro	1-1/16	Mech. Driven	—	—	—	—	—	.3	4500	6.3V 100~	—	—
Tachometer Squirrel Cage Rotor	15	15 5151-01	Syn-chro	1-13/64	Mech. Driven	—	—	—	—	—	1.3	4500	115V 400~	50	—
A.C. Tachometer D.C. Motor	15	15-MTG 6276-01	Syn-chro	3-7/16	D.C.	2	11,000	—	28 D.C.	—	.25	5000	115V 400-1200~	25	15°
Damping	21	D 5851-01	Face	2-11/16	400~	3.5	7,500	40	115	115	.022	6500	26V 400~	—	—
D.C. Tachometer	12	12-D 8301-02	Face	2-1/4	Mech. Driven	—	—	—	—	—	2.7	8000	P.M.	—	—

						Phase 1 Output Voltage	Phase 1 Output Current	Phase 2 Output Voltage	Phase 2 Output Current	Output Frequency	Speed At Rated Output	Type Motor	Torque Input
Dual Output	10	6702-01	Syn-chro	1-5/8	Mech. Driven	67	.011 A	1.4	.150 A	400~	12,000	P. M.	—
A.C. Power	17	6951-03	Syn-chro Spec.	1-9/16	Mech. Driven	24	.85 A	24	.85 A	420~	12,600	P. M.	3.5 oz.in.
Reference	25	23-TG 6776-01	Syn-chro	4	Mech. Driven	40	.0375 A	40	.0375 A	35~	2,100	P. M.	—

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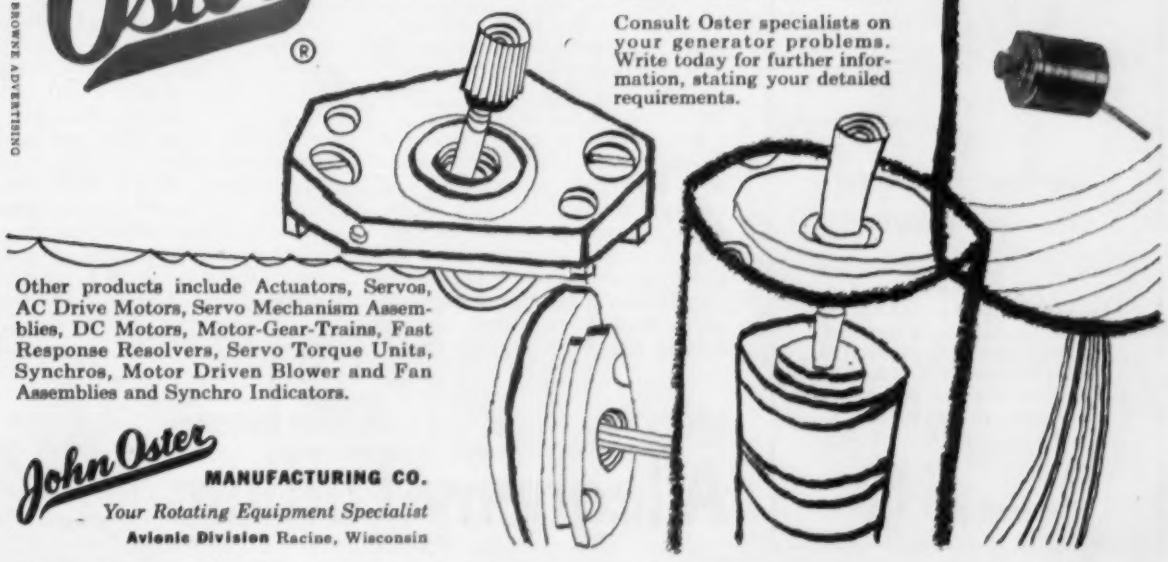

Other products include Actuators, Servos, AC Drive Motors, Servo Mechanism Assemblies, DC Motors, Motor-Gear-Trains, Fast Response Resolvers, Servo Torque Units, Synchros, Motor Driven Blower and Fan Assemblies and Synchro Indicators.

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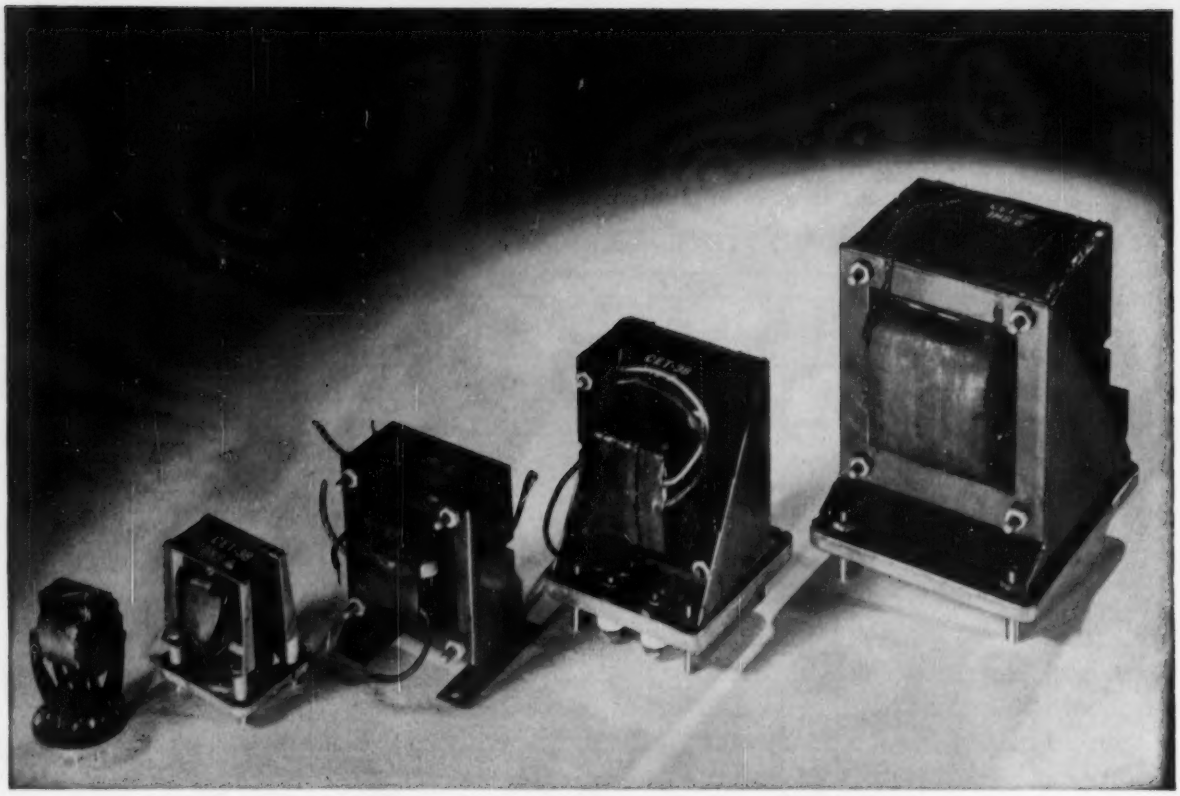

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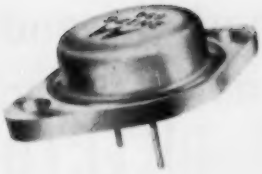

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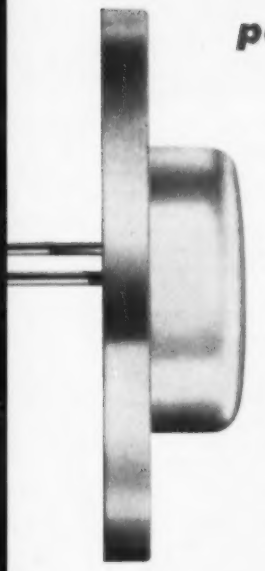

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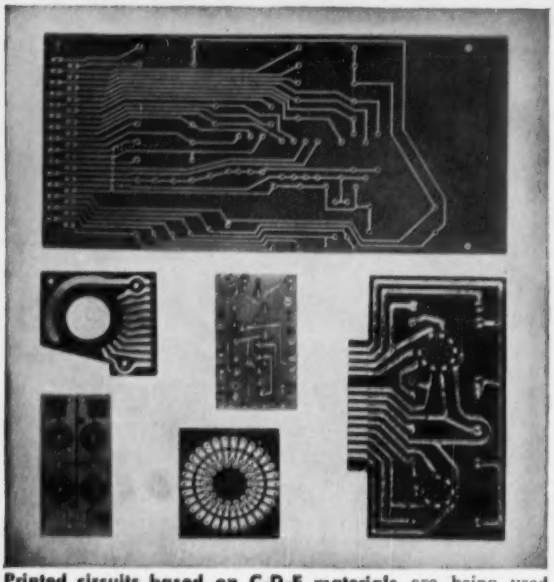

Printed circuits based on C-D-F materials are being used with great success in military electronic equipment, commercial television and radio sets, telephone switchboards—even sub-miniature radiosonde equipment and hearing aids.

Photos courtesy of Photocircuits, Inc., Glen Cove, N. Y.

HIGH BOND STRENGTH—C-D-F's special adhesive for metal-clad Dilecto bonds the copper foil to the plastic without affecting the laminate's superior electrical properties. Heat-resistance, dissipation factor, dielectric constant, dielectric strength, and insulation resistance of the Dilecto base remain unaffected. The closely-bonded foil can be etched cleanly and dipped in hot solder to 450°F. for ten seconds with a guarantee of no blistering or separating. Metal-Clad Dilecto can be punched or machined either before or after etching.

EXCELLENT WORKABILITY—On all four Dilecto metal-clad grades, you can solder, punch, saw, and assemble components either by hand or automatically. Thanks to the inherently superior workability of the plastics laminate over that of ceramic-type materials, Dilecto can be dropped, jammed into tight chassis, and otherwise treated roughly on the assembly line and in service.

HIGH HEAT-RESISTANCE—Metal-Clad Dilecto Laminates are made of phenolic, epoxy, or Teflon* resin for various conditions of service and assembly, and have either cellulosic paper or woven glass-fabric base. All are ideally suited to printed-circuit applications in which heat-dissipation is a major problem. Continuous exposure to high ambient operating temperatures in enclosed electronic equipment has no significant effects on Dilecto's electrical and physical properties.

UNLOAD YOUR HEADACHE HERE! C-D-F, a big, reliable source of supply, can help you get the most for your printed-circuit money by reducing rejects, lowering fabrication costs, assuring dependable quality every time. Send us your print or problem, and we'll gladly supply appropriate test samples free. See our catalog in the Product Design File (Sweet's) or send for the new 20-page Dilecto catalog. Let your nearby C-D-F sales engineer (listed in Sweet's) help you right from the design stage!

TYPICAL PROPERTY VALUES

	Copper-Clad PHENOLIC (Grade XXXP-26)	Copper-Clad PHENOLIC (Grade XXXP-28)	Copper-Clad EPOXY (Grade GB-181E)	Copper-Clad TEFLON* (Grade GB-112T)
BOND STRENGTH—0.0014" foil (Lbs. reqd. to separate 1" width of foil from laminate)	7 to 11	5 to 9	8 to 12	4 to 8
MAXIMUM CONTINUOUS OPERATING TEMP. (Deg. C.)	120	120	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil.)	800	800	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35° C. & 90% RH	50,000	25,000	20,000	Over 10^6 megohms
DIELECTRIC CONSTANT 10^6 Cycles	4.20	4.20	4.54	2.85
DISSIPATION FACTOR 10^6 Cycles	0.026	0.052	0.018	0.0006
ARC-RESISTANCE (Seconds)	10	5	120	180
TENSILE STRENGTH (psi.)	16,000 x 13,000	12,000 x 10,000	48,000 x 44,000	23,000 x 21,000
FLEXURAL STRENGTH (psi.)	21,000 x 18,000	18,000 x 16,000	65,000 x 55,000	13,000 x 11,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.40 x 0.35	0.40 x 0.35	13.5 x 11.5	6.0 x 5.0
COMPRESSIVE STRENGTH flatwise (psi.)	28,000	22,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Cotton rag paper	Cotton rag paper	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural greenish	Natural Brown	Natural	Natural

All these standard grades are available with 0.0014", 0.0028", 0.0042", or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

*duPont Trademark

CDF **CONTINENTAL DIAMOND FIBRE**

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NEWARK 16, DELAWARE

FOR SPATIAL REFERENCE

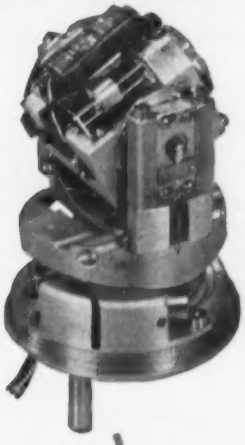
Gyros

BY

Greenleaf

QUALITY ABOVE ALL!

Two Degree of Freedom Gyro Unit



1. GYRO MOTOR DATA

*a. 115 VAC 400 CPS 1 and 3 Phase
b. Angular Momentum .6 In. Lbs./Sec. at 24,000 R.P.M.
c. Warm-up Time 1 Minute at 78° F.
d. Temperature—From -65°F. to +180°F.

2. GYRO OPERATIONAL DATA

*a. Can be furnished to detect pitch, yaw and roll or combination of any two.
*b. Accuracy—Roll Position indicated to a Minimum of ±3° over Full Range of 360°.
c. Drift Rate—1.0° per Minute Maximum.
*d. Gyro Freedom—Inner Gimble ±70°. Outer Gimble 360°.

3. PICK OFF DATA

*a. Type—Potentiometer
*b. Linearity—0.3%
*c. Resolution—.25°
*d. Resistance—5000 ohms
e. Excitation—5 Volts D.C.
f. Dead Space—2° Maximum
g. Synchro Pickoffs also available

4. CAGING MECHANISM

*a. Electrical Uncaging 28 Volts D.C.
*b. Mechanical or Electrical Caging

*Can be modified to conform to customer's requirements.

The Greenleaf Line of Gyros and associated devices is being steadily expanded. It now includes a wide selection of Free and Rate Gyros, and the HIG-3 and HIG-4 Gyros.

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GRE-66

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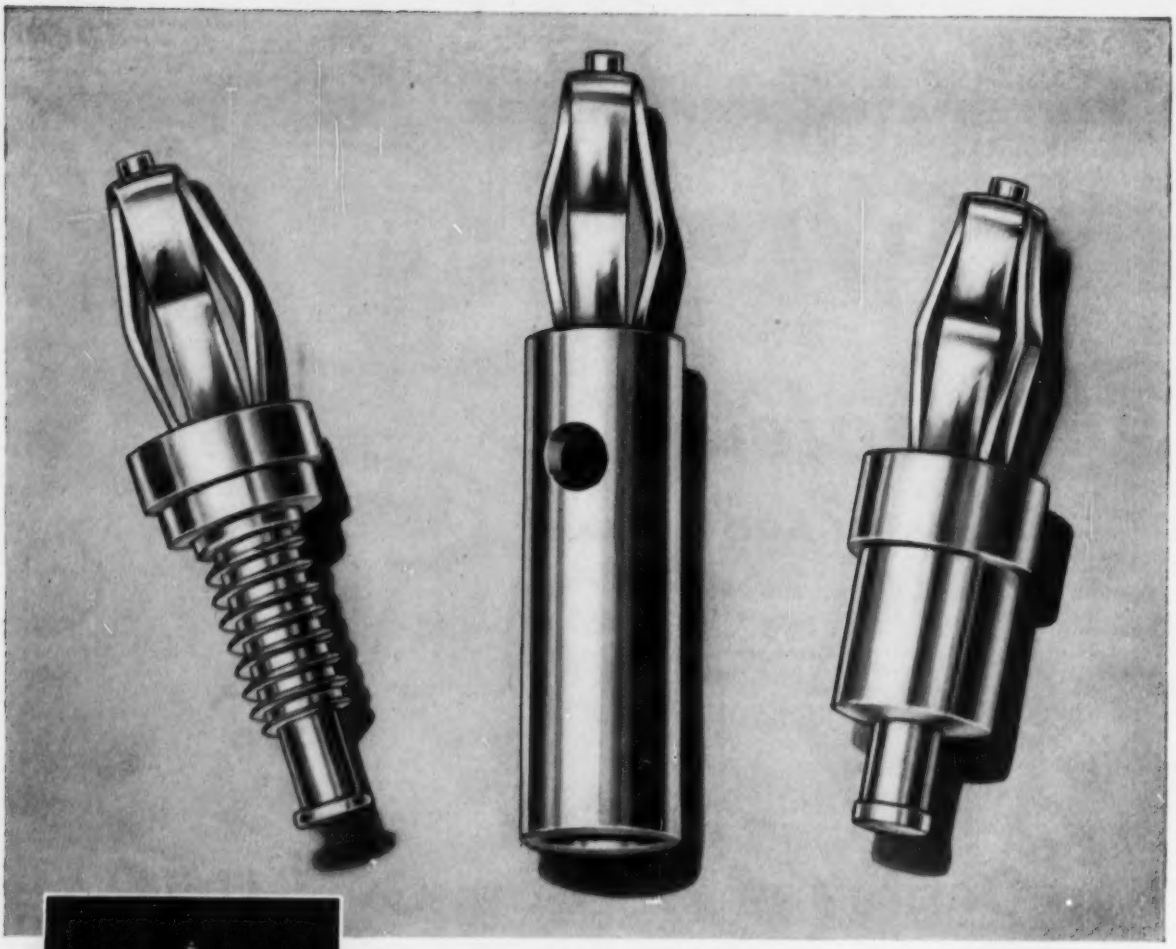
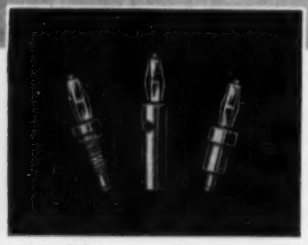


6 times enlargement



Actual size

Ucinite Miniature Banana Pins

Heavy resistance to torque is a big feature of Ucinite miniature banana pins. The springs are mechanically riveted over and the large area around the tip of the pin is bonded by solder.

Pins are available in a variety of types, for assembly by staking . . . with nuts and washers . . . with soldered tails . . . with multiple plug-in features. Springs are designed to fit .093 sockets.

Built to withstand rough usage, Ucinite miniature banana pins are available in cadmium, silver or gold plate.

For further information, call your nearest United-Carr representative or write directly to us.

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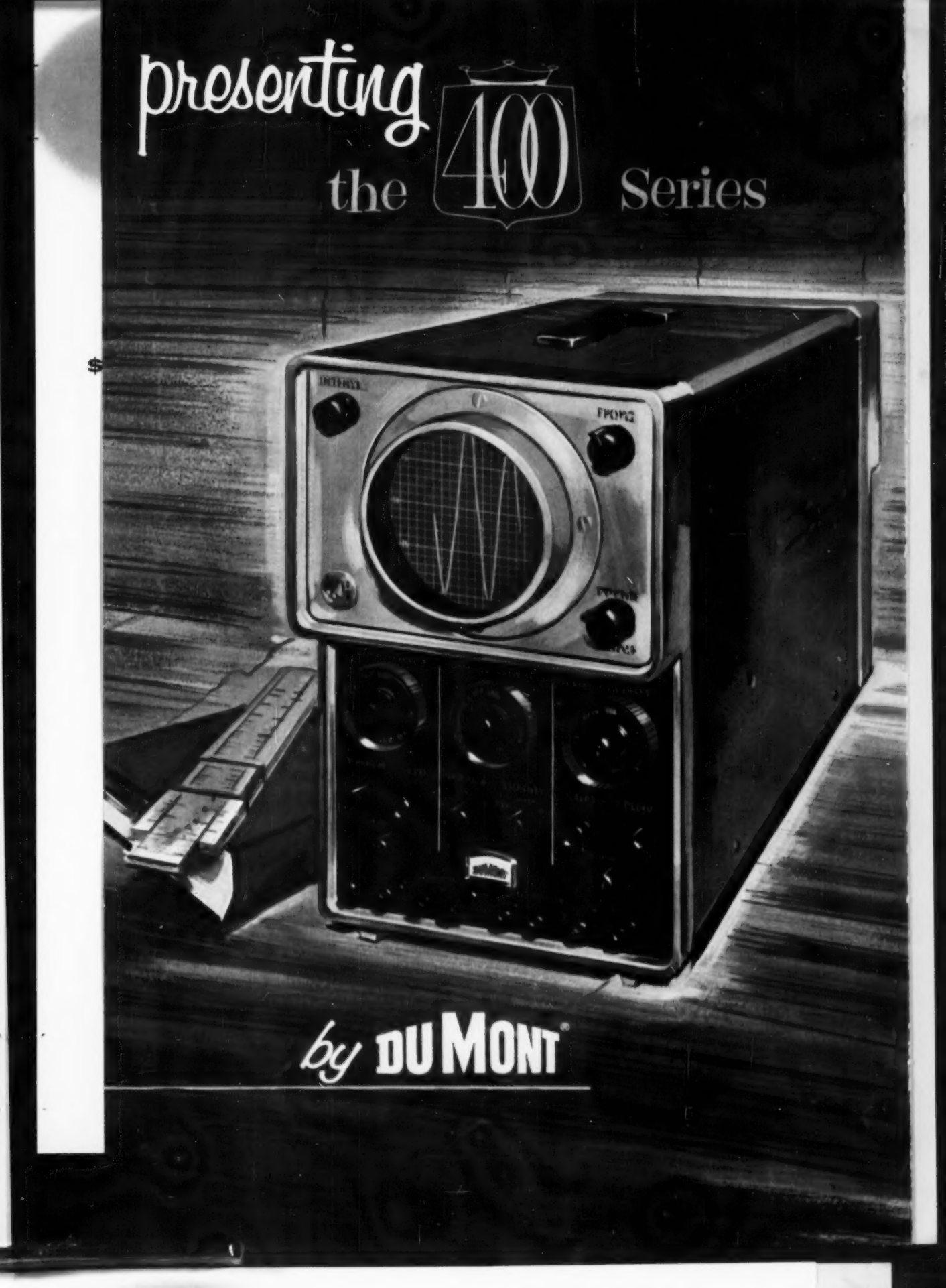

presenting
the 400 Series
by DU MONT®

TYPE 401 Low-Frequency Oscillograph

$420.00
Domestic Price

Combining superb electronic circuitry with "Efficiency Engineered" design, the 401 brings complete, high quality, quantitative measurement to the medium-price range for the first time. The 401 is executed in the philosophy of the 400 series (see details on page 4) and brings a new high in precision, ease of operation and convenience to the low-frequency field.

Linear, Calibrated Sweeps: Simple, accurate, sweep calibration is available on all ranges. Linear hard-tube sweeps are expandable up to 3 times with no on-screen distortion. The sweep range of 125 milliseconds to 10 microseconds per inch is ample for all applications within frequency handling capability of the deflection amplifiers. Extra S-L-O-W sweeps are available by addition of an external capacitor.

Identical X and Y Amplifiers: Identical deflection amplifiers offer a sensitivity of 100 millivolts full scale (25 millivolts per inch) and a frequency response from dc to down less than 3 db at 150 kc. Relative phase shift between amplifiers is less than 1° below 150 kc, making the 401 ideal for phase shift studies. Precision attenuators provide an extra measure of convenience.

Stability: Unparalleled stability is achieved through the use of a self-regulating power transformer and electronic regulation, including the c/r-t high voltage. The result – the instrument is unaffected by changes in the primary voltage over an extremely broad range and, after a short warm up time, drift is virtually non-existent.

Amplitude Calibration on Both Axes: Simple push button calibration of *both X and Y axes* is provided, with no inconvenient patch-overs needed. Overall accuracy of Amplitude Calibration is 5%.

Beam Gate: The internally generated beam gate turns on the cathode-ray beam only during the forward trace. Thus on driven sweeps the troublesome stationary spot before sweep "go-time" is eliminated, greatly facilitating oscillograph recording. Should the retrace be desired, an over-ride feature built into the brightness control permits display of the retrace portion of the sweep. Also, if the X amplifier is to be used with an external signal, the beam gate may be set so that it continues to function to provide intensity modulation marks or, for photographic work, to turn the display on for a desired length of time. The beam gate is available at a convenient front binding post as a test signal or to synchronize accessory equipment.

Tight Tolerance 5ADP c/r-t with high accelerating Potential: Consistent with the precision inherent in the circuitry of the 401, the high-precision Du Mont Type 5ADP c/r-t is employed, and provides a display that is essentially free from field distortions and deflection non-linearities. 3,000 volts of accelerating potential provides a bright, sharp trace and assures sufficient screen excitation to take full advantage of long-persistence screens, even at low repetition rates.

Long-Term Reliability: *Real* reliability has been achieved through accurate component evaluation during design, extensive quality control tests, and by unusually rugged mechanical design, insuring an instrument that works – and stays working. (See page 4)

Additional Features Include: Removable side and bottom panels for easy tube changing. Tried-and-proved printed circuits. Integral c/r-t shield and clamp. c/r-t alignment lever. Edge illuminated calibrated scale.

The 401 – descendant of the oldest and and most honored line of general function oscillographs ever built – is the most advanced instrument ever offered in the medium-price range, incorporating every feature for true precision qualitative and quantitative studies within the dc to 150 kc bandwidth. Write for a demonstration of this unique instrument today.

401-R FOR RACKMOUNTING

The 401-R is identical in every respect to the 401, except that the 401-R has been mechanically rearranged for mounting in standard 19-inch relay racks. Price: $450.00

MAJOR SPECIFICATIONS

Vertical Deflection: Sinewave response extends flat from dc to 150 kc. (Less than 3 db down at 150 kc ±15 kc). Deflection sensitivity, 25 mv/in or 100 mv full scale. Calibration standard built-in.

Horizontal Deflection: Identical to the vertical axis.

Sweeps: 18 calibrated ranges including 5 overlaps. Using internal timing capacitors, sweeps from 125 ms/in to 10 us/in are instantly available. Slower sweeps are obtained with external capacitor.

Amplitude Measurement: (both X- and Y-axes) 0.1, 1, 10 and 100 volts full scale; accuracy, ±5%.

Relative Phase Shift Between Amplifiers: Easily set for less than 1° at frequencies below 150 kc.

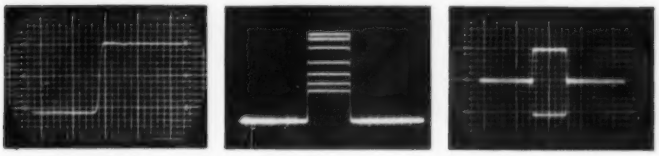
Cathode-ray Tube: Tight tolerance Type 5ADP-, operated at 3000 volts acceleration.

Catalog No.	Description
4001-K	5ADP1 c/r-t; 115-V, 60 cps
4002-K	5ADP7 c/r-t; 115-V, 60 cps
4003-K	5ADP11 c/r-t; 115-V, 60 cps
4004-K	5ADP1 c/r-t; 230/115-V, 50 cps
4005-K	5ADP7 c/r-t; 230/115-V, 50 cps
4006-K	5ADP11 c/r-t; 230/115-V, 50 cps

Join the 400

TYPE 404 Pulse-Generator

Here is the pulse generator you have been dreaming about – a rugged, reliable source for high speed pulses that are free of bumps and squiggles. Another in the DuMont 400 series, the 404 offers unusually great range of pulse widths and repetition rates together with unprecedented ease and convenience of operation.
(See page 4)



1. Leading edge of the pulse connected directly to cathode-ray tube deflection plates. Sweep rate is 0.1 usec/major division.

2. Multiple exposure of 1-usec pulse connected directly to deflection plates shows excellent characteristics of push-button attenuator. Attenuations are ½ db + 1 db + 2 db + 2 db + 2 db + 2 db for a total of 9½ db. Note faithful preservation of waveform regardless of attenuator setting.

3. Double exposure of 1-usec pulse connected directly to deflection plates shows positive and negative pulse outputs.

Wide Range of Pulse Widths and Amplitudes: The 404 offers such a broad range of pulse widths, amplitudes and repetition rates that a judicious selection of the right combination can be made to simulate virtually any test condition. Pulse widths are continuously variable from .05 usec to 100 usec. Rise or fall time is less than 0.018 usec.

Pulse Repetition Rate 100,000 PPS to Single Pulse Operation: The 404 offers complete freedom of choice between pulse width and repetition rate within the restriction of a 10% duty cycle. Thus, any pulse width from 1 usec down to .05 usec may be operated up to the full 100 kc rate while pulses longer than 1 usec in duration are limited in repetition rate only by the 10% duty cycle consideration. *Positive automatic protection assures that no combination of front panel controls can damage the 404.*

If the duty cycle limit is reached, it is automatically reduced to a safe value and a front panel warning light flashes. Single pulses of any preset width and amplitude can be initiated by a front-panel push button. The 404 also includes control from an external positive or negative trigger, again at rates from a single pulse to 100,000 pps.

Precision Push-Button Attenuator Controls Pulse Amplitude from 0 to 60 db Attenuation: Maximum amplitude of the output pulse is 50 volts, with an output impedance of 50 ohms. With the built-in precision attenuator of the instrument, the amplitude can be attenuated up to 60 db in ½ db increments with 3% accuracy. Since all controls are switch or push-button actuated, any amplitude can be duplicated at any time with perfect *accuracy* simply by duplicating switch settings. The ½ db steps are fine enough for all practical uses. This feature is most valuable in production or standards test set ups where exact control settings can be specified for any range of test conditions and duplicated faithfully.

Pulse shape is completely independent of attenuator setting. Pulse rise time and lack of overshoot remain the same so that, at maximum attenuation, the pulse is fully as reliable for measurements as the 50-volt unattenuated pulse.

Jitter-Free Trigger Output: Hard-tube circuitry used in the 404, as compared to that found in conventional hydrogen thyratron pulse generators, assures jitter-free relationship between pulse and trigger.

With internal trigger, the pulse start can be varied continuously from 2 usec before to 8 usec after the trigger. The trigger output is normally used to initiate the time-base on a cathode-ray oscillograph before the pulse appears at the deflection plates. The available delay range between pulse and trigger makes it possible to position the most useful information on the screen.

The pulse may also be triggered from external sources.

A backlash potentiometer is used on the pulse delay control providing both coarse and vernier action with one knob.

404-R FOR RACKMOUNTING

The 404-R is identical in every respect to the 404, except that the 404-R has been mechanically rearranged for mounting in standard 19-inch relay racks.

MAJOR SPECIFICATIONS

Pulse Output: Nominally 50 volts across 50 ohms; Attenuator provides up to 60 db attenuation in ½ db increments; Attenuator accuracy: ±3%; Overshoot less than 3%; positive or negative pulse polarity.

Pulse Duration: Width, 0.05 usec to 100 usec continuously variable; Rise or fall time less than 0.018 usec; duty cycle, 10%, automatic, built-in overload protection.

Repetition Rate: Internal, external or manual. Internal 10 pps to 100,000 pps; continuously variable. Facilities for external trigger up to 100 kc. Manual trigger push button for single pulse operation.

Trigger Output: 25 volts across 50 ohms positive or negative. Rise time less than 0.05 usec; width, 0.1 usec.

Pulse Delay: −2 to +8 usec with respect to internal or manual trigger; continuously variable. Delay from +3 to +13 usec after 2 volt point on leading edge of external trigger; continuously variable. Duty cycle 80%. (Maximum delay at 100,000 pps rep rate is 8 usec.)

Cat. No.	Description
4013-K	115-V; 50/60 cps

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. . . BUY DUMONT

The DuMont 400 Series

A NEW PHILOSOPHY IN INSTRUMENT DESIGN

In the 400 design, DuMont expends the same care in adapting the instrument to the capabilities and perceptions of the user, as in adapting the electronic circuitry to the range of application. As a result, the engineer enjoys a novel freedom from the annoying mechanics of instrument operation and can devote his full attentions to the basic purpose of the investigation at hand. Work efficiency is increased; fatigue, reduced. And, most important, the ease and convenience of the DuMont 400 Series instruments makes your work much more fun.

VISUAL EFFICIENCY

No squinting here . . . Lettering in clearly contrasting colors, selected after extensive readability tests, make readings easier, more certain. And on calibration controls, unique read-out system makes your CRO practically a digital device for reading amplitude and time. Thus, the possibility of human error is substantially reduced.

MECHANICAL EFFICIENCY

More than a simple, logical grouping, all controls are arranged in basic *blocks of function*. For example, in a Series 400 CRO, the panel is first broken into two distinct units, the upper indicator portion with the cathode-ray tube, and its controls (intensity, focus, etc.) and the lower, an entirely separate panel, bearing the balance of the controls. The lower panel is again grouped into related functions, for the X- and Y-axes, and sweeps. Also, binding posts are so located that all connecting leads are conveniently away from operating controls.

Where appropriate, simple push-push switches are used. Such switches obviate inconvenient patch-overs for voltage calibration, for example, or, in another case (See illustration below) as a uniquely simple, precision attenuation selector.

DEPENDABILITY

Rugged . . . inside and out. Sturdy castings completely encircle the instrument providing unusually great mechanical protection. A number of new construction techniques are employed in the 400 Series to assure true durability. In the CRO, for example, a novel integral tube shield and mounting bracket virtually eliminates the possibility of breaking the cathode-ray tube, even if the instrument should be dropped.

Electrically, careful circuit design, conservatively rated components, and an exacting quality control program assure an instrument that will work properly, AND STAY WORKING PROPERLY, for extended periods of time, even under the most adverse field conditions.

DEPENDABILITY IS NO IDLE WORD WITH THE DU MONT 400 SERIES. A WHOLLY NEW CONCEPT OF TROUBLE-FREE PERFORMANCE IS AN INTEGRAL PART OF THE PHILOSOPHY OF THE 400 SERIES. IT IS BACKED BY THE MOST LIBERAL GUARANTEE IN THE ELECTRONICS INDUSTRY. (SEE BELOW)

Particular care is taken in the 400 instruments to assure minimum down-time, should tube replacement become necessary. Unique fall-away side panels are used where appropriate. At the turn of a pair of screws, either side of the cabinet may be quickly removed.

GUARANTEE

In addition to the standard Du Mont Guarantee which covers all components and service of the instrument for a period of one year (CRT for six months), Du Mont guarantees printed wiring and transformers in the 400 Series Instruments for a period of five years and the cathode-ray tube for one year from date of purchase.

DU MONT Technical Sales Department,
ALLEN B. DU MONT LABORATORIES, INC.,
CLIFTON, N. J.

Installation of Leesona No. 107 Coil Winders at Ford Motor Company's Ypsilanti, Michigan, plant. New Paper Miss Detector enables operator to tend two machines.

Now FORD Motor Co. winds ignition coils on Leesona No. 107 winders

Machines stop automatically if there's a paper miss . . . one operator tends two machines . . .

These Leesona No. 107 Coil Winders, equipped with the new Paper Miss Detector, make quantity production of high-quality stick-wound coils virtually foolproof.

Humidity changes can cause the paper to curl and miss an insert. Ordinarily, if there's a paper miss, and the machine is unattended, it continues to wind. Result . . . a worthless stick plus money wasted in wire and time. So an operator must be in constant attendance on each machine.

The new Leesona Paper Miss Detector cures this . . . by automatically stopping the machine. Thus, constant machine attendance is unnecessary.

- One operator can handle two or three machines.
- Operator's coil production increases.
- Rejection rate is reduced . . . when the machine stops at a paper miss the operator re-inserts the paper, starts the machine which continues to wind an excellent stick of coils.

For the full story on Leesona No. 107 Coil Winders, and other helpful information write or get in touch with Universal.

B.5.2

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Low modulation, but good permeability	C, GS6
Stability	E, TH, SF
Density	HP
Green Strength	L, HP, MR
Smooth machining	E, TH, SF
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Modern miracles like this happen every day at Harvard University's Agassiz Station Observatory, where a giant new radio telescope, with its 60′ Kennedy antenna, is taking man further back in time . . . and further out into space . . . than he has ever been before.

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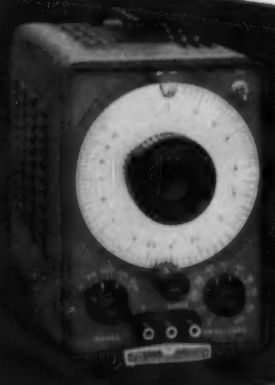
6 cps to 6 KC. -hp- 200J replaces -hp- 200I, for interpolation, frequency measurement, etc., where frequencies must be known precisely. New 160 mw balanced output, less than 0.5% distortion, frequency stability ± 2% or 0.2 cps. Six spread-scale frequency ranges, effective scale length 80" for maximum resettability. Calibration accuracy is ± 1%, frequency response ± 1 db full range. Output 160 mw or 10 v into 600 ohms, or 20 v open circuit, balanced to ground. Hum voltage less than 0.1% of output. $275.00.

20 cps to 20 KC. -hp- 201C. Like popular -hp- 201B but more accurate attenuator, compact cabinet, lower price. Provides low distortion, high accuracy output for amplifier, loudspeaker, frequency comparison and other high fidelity measurements. Frequencies covered in 3 bands, calibration accuracy ± 1%, frequency stability ± 2% or 0.2 cps, frequency response ± 1 db full range. Output 3 watts or 42.5 v into 600 ohms. Distortion less than 0.5% above 50 cps. Output attenuator adjusts voltage 0 to 40 db, provides either low or constant 600 ohm impedance. $225.00.



1 cps to 100 KC. -hp- 202C. New, multi-purpose instrument replacing -hp- 202B. Excellent wave-form for subsonic, audio, supersonic measurements in laboratory, field, factory. New broad frequency range, 160 mw balanced output, less than 0.5% distortion, high frequency stability, short recovery time (5 secs. at 1 cps), lowered price. Frequencies covered in 5 bands; frequency response ± 1 db full range, output 160 mw or 10 v into 600 ohms, 20 v open circuit, balanced to ground. Hum voltage less than 0.1%. $300.00.

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Utmost convenience and precise accuracy. Low distortion, high stability, wide frequency range, simple operation without resetting or adjustment. Attractive new cabinets, light and portable, yet rugged and compact.

The famous RC oscillator circuit, pioneered by *-hp-*, today refined to a high new level of performance and capability.

-hp- quality construction. Long-life electrolytic condensers, premium cost surface treated insulators, precision mechanical assemblies, specially built, 100% inspected transformers. All are standard in *-hp-* instruments to insure freedom from electrical and mechanical trouble, or the effects of dust, humidity and hard use.

These are the basic features of the three new *-hp-* oscillators now joining the 60,000 other *-hp-* RC oscillators in use throughout science, the military and industry.

These same features are fundamental in every *-hp-* oscillator. Every instrument bearing the Hewlett-Packard name is designed for the utmost in convenience, dependability, accuracy—the standard of quality in instrumentation, the very finest of its type made anywhere—yet available to you at a reasonable price.

hp provides complete coverage of your oscillator requirements

Oscillators—.008 cps to 10 MC

Instrument	Primary Uses	Frequency Range	Output	Price
-hp- 200AB	Audio tests	20 cps to 40 KC	1 watt/24.5 v	$130.00
-hp- 200CD	Audio and ultrasonic tests	5 cps to 600 KC	160 mw/20 v open circuit	160.00
-hp- 200J	Interpolation, frequency measurements	6 cps to 6 KC	160 mw or 10 v/600 ohms; 20 v open circuit	275.00
hp- 200T	Telemetry, carrier current tests	250 cps to 100 KC	160 mw or 10 v/600 ohms; 20 v open circuit	350.00
hp- 201C	High quality audio tests	20 cps to 20 KC	3 watts or 42.5 v/600 ohms; one terminal grounded	225.00
-hp- 202A	Low frequency measurements	.008 to 1200 cps	20 mw/10 v	465.00△
-hp- 202C	Low frequency measurements	1 cps to 100 KC	160 mw or 10 v/600 ohms; 20 v open circuit	300.00
-hp- 205AG	High power tests, gain measurements	20 cps to 20 KC	5 watts	440.00△
-hp- 206A	High quality, high accuracy audio tests	20 cps to 20 KC	+ 15 dbm	565.00△
-hp- 233A	Carrier test oscillator	50 cps to 500 KC	3 w/600 ohms	475.00
-hp- 650A	Wide range video tests	10 cps to 10 MC	15 mw/3 v	490.00△

△ Rack mounted instrument available for $15.00 less.

Data subject to change without notice. Prices f.o.b. factory.

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FABRICATION: Fabrication characteristics are equal to those of standard magnesium alloys.

WELDABILITY: 95 to 100% weld efficiency at elevated temperatures.

FORMABILITY: Single deep draws can be easily accomplished.

MACHINABILITY: Best machining characteristics of any structural metal.

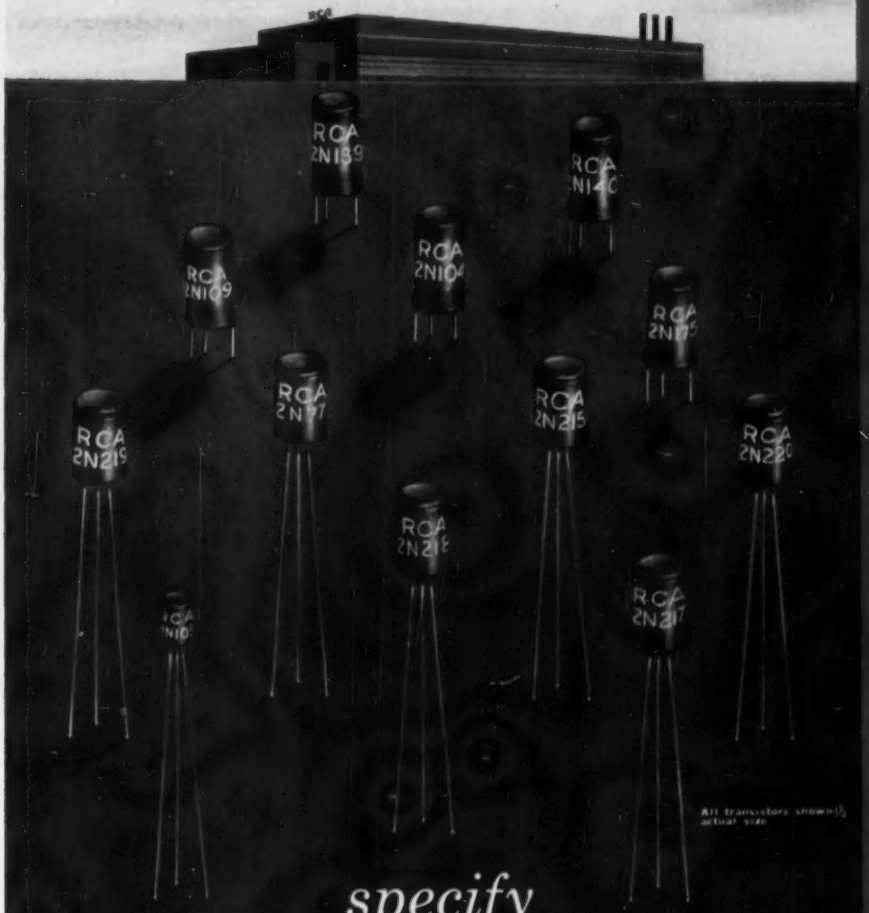
One of the new alloys is magnesium-thorium composition HK31A. It is now available in rolled form from stock. Castings and sheet in mill quantities are also readily available. A companion alloy for extruded shapes and forgings will soon be in production.

For more information about the new high temperature magnesium alloys, contact your nearest Dow Sales Office or write to THE DOW CHEMICAL COMPANY, Magnesium Sales Department MA 362KK-1, Midland, Michigan.

EASILY FORMED. These HK31A parts were drawn using production dies and processes for standard magnesium alloys. The parts retained a higher percentage of original properties than standard alloys.

you can depend on DOW MAGNESIUM DOW

FOR QUALITY IN QUANTITY



specify

RCA TRANSISTORS

Whether you are a "ham," experimenter, service technician, or design engineer—building a rig, becoming familiar with transistors, replacing one in a set, or constructing a production prototype—you want exactly what RCA TRANSISTORS offer—high quality, long life, and uniformity of electrical characteristics. Because of the exceptional uniformity in characteristics of RCA transistors, each RCA TRANSISTOR of a type can be replaced with RCA transistors of the same type without need for circuit adjustments. Whether you need a few, one hundred, or one hundred thousand transistors —*for quality, specify RCA TRANSISTORS.*

AVAILABLE THROUGH RCA DISTRIBUTORS . . . NOW!

RCA TRANSISTORS

SEMICONDUCTOR DIVISION, SOMERVILLE, N. J.

RCA-2N77 . . . For low-power audio-frequency amplifier service. Has flexible leads which may be soldered or welded into the associated circuits.

RCA-2N104 . . . For low-power audio-frequency applications. Has a linotetrar 3-pin base.

RCA-2N105 . . . For low-power audio-frequency amplifier service where extremely small size is a requirement. Has flexible leads which may be soldered or welded into the associated circuits.

RCA-2N109 . . . For class B power output stages of battery-operated portable radio receivers and audio amplifiers operating at power output levels of approximately 150 milliwatts. Has a linotetrar 3-pin base.

RCA-2N139 . . . For 455-Kc audio-frequency amplifier applications in transistorized portable radios and automobile radios. Has a linotetrar 3-pin base.

RCA-2N140 . . . For converter and oscillator applications in standard-AM-broadcast-band transistorized portable radios and automobile radios. Has a linotetrar 3-pin base.

RCA-2N175 . . . Low-noise type (2 db max.) for use in pre-amplifier or input stages of transistorized audio amplifiers operating from extremely small input signals. Has a linotetrar 3-pin base.

RCA-2N215 . . . Has same electrical characteristics as 2N104 but has flexible leads.

RCA-2N217 . . . Has same electrical characteristics as 2N109 but has flexible leads.

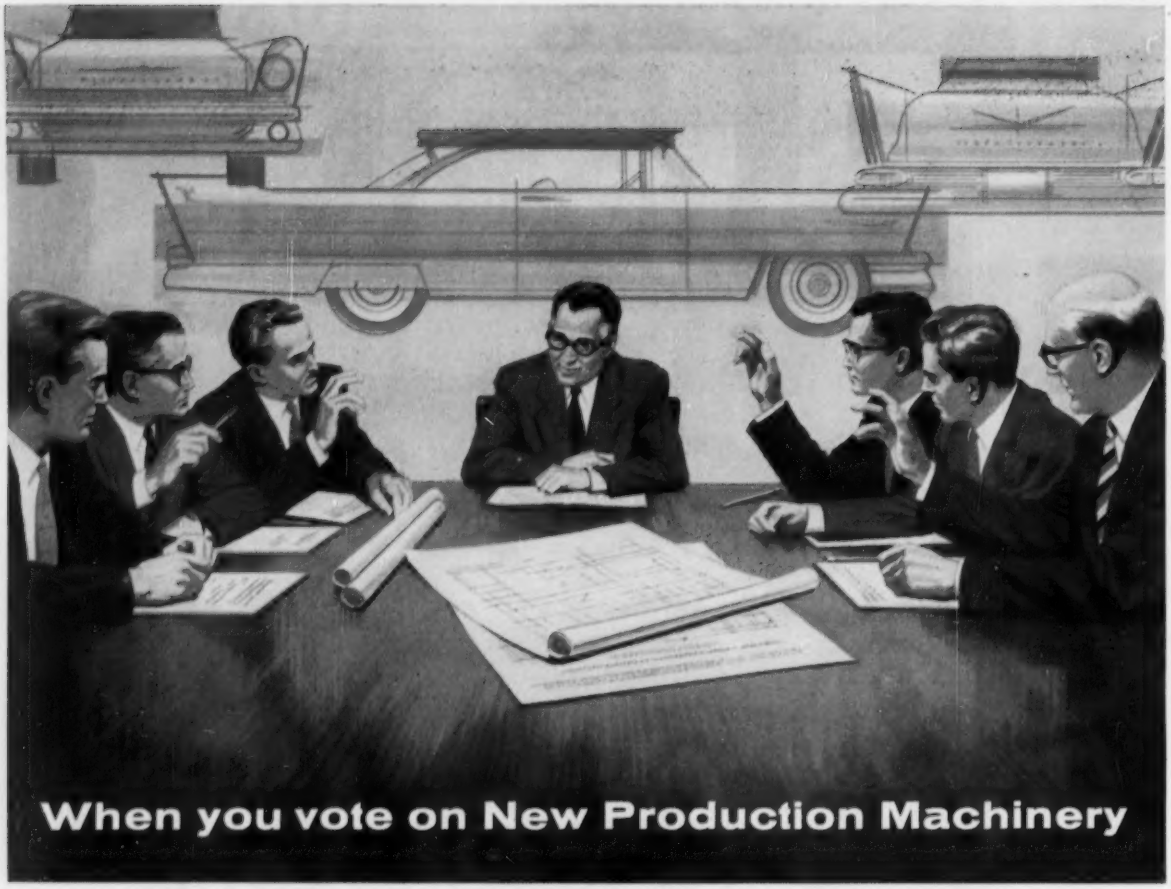
RCA-2N218 . . . Has same electrical characteristics as 2N139 but has flexible leads.

RCA-2N219 . . . Has same electrical characteristics as 2N140 but has flexible leads.

RCA-2N220 . . . Has same electrical characteristics as 2N175 but has flexible leads.

NEW PLANT IN OPERATION . . . To meet the ever-increasing demand for high-quality RCA TRANSISTORS, a new plant has been constructed at Somerville, N. J. It is equipped with the most modern production and inspection facilities to maintain RCA's high standards for quality.

Want more information? Use post card on last page.



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There's no real substitute for American-made production machinery in any branch of American industry. Designed and built to take the strains and stresses of the world's toughest demands for speed and endurance . . . with a minimum of down-time and maintenance . . . American machines are today more than ever the best buy in every field from textiles to metal-working. Yes, American production machines are the backbone of America's competitive economy . . . *and why settle for anything else?*

VEEDER-ROOT INC.

"The Name that Counts"

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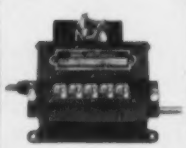
. . . and here's why it pays to make sure that All New Machines you buy are equipped with NEW VEEDER-ROOT COUNTERS...

Modern Veeder-Root Counters are available for *building into* . . . or attaching onto . . . all types of production machines. They are built with unmatched Veeder-Root know-how and quality for years of accurate Countrol of production and uniformity. Ask your Industrial Supply Distributor or write Veeder-Root Inc., Hartford 2, Conn.

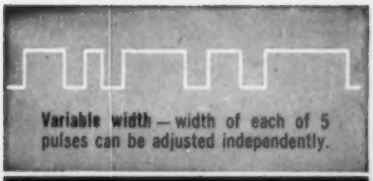
Hand Counting: Very-Tally Multiple Unit Reset Counters for inventory, inspection and 1,001 hand-counting jobs. Up to 108 counters in 1 bank.

Mechanical Counting: Small resets count strokes, turns, pieces . . . are built into machine tools, light presses, etc.

Electrical Counting: Remote indicating counters (AC or DC) bring your production machines as close as your office wall. May be panel-mounted in groups.

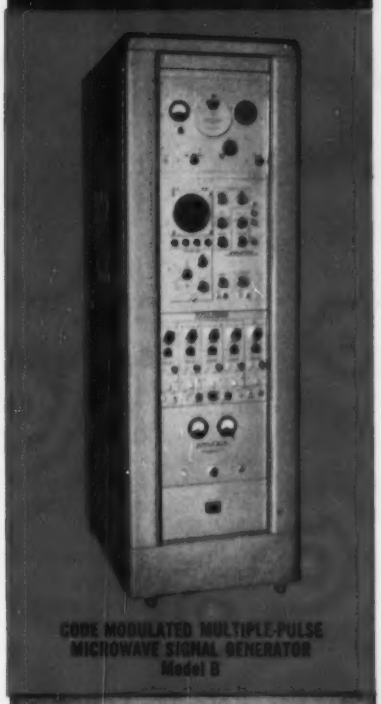


Controlling: Set for number of turns, pieces or operations required. Predetermining Counters control the run exactly . . . prevent over-runs and shortages.



Variable width—width of each of 5 pulses can be adjusted independently.

Variable delay—delay between each of 5 pulses can be adjusted independently.



CODE MODULATED MULTIPLE-PULSE MICROWAVE SIGNAL GENERATOR Model B

Pulse-time modulation—input provided in each of 5 pulse channels for external pulse-time modulation.

Variable repetition rate—repetition rate of each group of pulses can be varied.

CODE MODULATED MULTIPLE-PULSE MICROWAVE SIGNAL GENERATOR

Model B 950-10,750 mc

Generates multi-pulse modulated carrier for beacons, missiles, radar... provides 5 independently adjustable pulse channels, 4 interchangeable r-f oscillator heads, precision oscilloscope, self-contained power supplies ...all in one integrated mobile instrument.

The Polarad Model B is an essential instrument for testing beacons, missiles, radar, navigational systems such as DME, Tacan, H. F. Loran, etc., where multi-pulse modulated, microwave frequency energy with accurately controlled pulse width, delay, and repetition rate is required for coding.

A fully integrated self-contained equipment with these features:

Four Interchangeable Microwave Oscillator Units—all stored in the instrument... each with UNI-DIAL control... precision power monitor circuit to maintain 1 mw power output reference level... keying circuit to assure rapid rise time of modulated r-f output... non-contacting chokes.

Five Independently Adjustable Pulse Channels—each channel features variable pulse width and delay; has provisions for external pulse-time modulation.

Precision Oscilloscope with Built-In Wide Band RF Detector for viewing the modulation envelope and accurately calibrating the r-f pulse width, delay, and group repetition rate. Equipped with built-in calibration markers.

Self-Contained Power Supplies—Model B operates directly from an AC line through an internal voltage regulator. The coded multi-pulse generator is equipped with an electronically regulated low voltage DC supply. Klystron power unit adjusts to proper voltage automatically for each interchangeable band.

Contact your Polarad representative or write to the factory for detailed information.

SPECIFICATIONS:

Frequency Range:
- Band 1 . . . 950 to 2400 mc
- Band 2 . . . 2150 to 4600 mc
- Band 3 . . . 4450 to 8000 mc
- Band 4 . . . 7850 to 10,750 mc

Frequency Accuracy . . . ±1%
RF Power Output . . . 1 milliwatt maximum (0 DBM)
Attenuator:
- Output Range . . . 0 to −127 DBM
- Output Accuracy . . . ±2db
- Output Impedance . . . 50 ohms nominal

RF Pulse Characteristics:
- a. Rise Time . . . Better than 0.1 microsecond as measured between 10 and 90% of maximum amplitude of the initial rise.
- b. Decay Time . . . Less than 0.1 microsecond as measured between 10 and 90% of maximum amplitude of the final decay.
- c. Overshoot . . . Less than 10% of maximum amplitude of the initial rise.

Internal Pulse Modulation:
- No. of Channels . . . 1 to 5 independently on or off
- Repetition Rate . . . 40 to 4000 pps
- Pulse Width . . . 0.2 to 2.0 microseconds
- Pulse Delay . . . 0 to 30 microseconds
- Accuracy of Pulse Setting . . . 0.1 microsecond
- Minimum Pulse Separation . . . 0.3 microsecond
- Initial Channel Delay . . . 2 microseconds from sync. pulse
- Internal Square Wave . . . 40-4000 pps (separate output)

Pulse Time Modulation:
- Frequency . . . 40-400 cps any or all channels
- Required Ext. Mod. . . . 1 volt rms min.
- Maximum deviation . . . ±0.5 microsecond

Power Input (built-in power supply) 105/125 v. 60 cps 1200 watts.

AVAILABLE ON EQUIPMENT LEASE PLAN

FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

POLARAD ELECTRONICS CORPORATION 43-20 34th STREET, LONG ISLAND CITY 1, N. Y.

PROVEN RELIABILITY

REPRESENTATIVES: Albuquerque, Atlanta, Baltimore, Boston, Buffalo, Chicago, Cleveland, Dayton, Denver, Fort Worth, Kansas City, Los Angeles, New York, Philadelphia, Portland, St. Louis, San Francisco, Schenectady, Syracuse, Washington, D. C., Winston-Salem, Canada; Arnprior, Ontario. Resident Representatives in Principal Foreign Cities

why development engineers like tucson

Our own engineers gave us some significant reasons:

They said, for instance, they like the dry, healthful climate—with an average of 11 hours of sunshine every day! They like the cultural atmosphere provided by the University of Arizona, as well as the educational opportunities offered. They like, too, the fact that Greater Tucson, with its population of more than 200,000, gives them all the advantages of metropolitan living—plus nearby mountains and places to hunt, golf, and ride.

One of the most important reasons they listed was the challenging and rewarding nature of the work at Hughes, the foremost electronics center in Arizona.

Today at Tucson expansion of our Research and Development Laboratories has created new, permanent positions for engineers with an E. E. or Physics degree who are interested in Video and IF circuitry, microwaves, switching circuits, pulse circuits, servomechanisms, electronic components, environmental and evaluation testing, and test equipment design.

Investigate now this opportunity to combine challenging work with wonderful living. Send your resume to L. V. Wike.

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

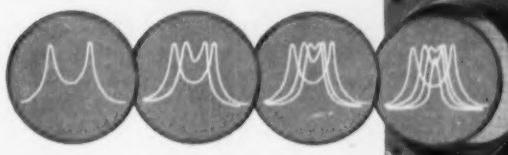
Hughes Aircraft Company, Tucson, Arizona

The Memo-Scope, incorporating the famous MEMOTRON, *combines the unique quality of information persistence with all the features of a superior quality laboratory oscilloscope.*

The Memo-Scope by Hughes is a storage oscilloscope that captures and retains any number of traces indefinitely at a constant intensity until intentionally erased. Traces are readily visible in a brightly-lighted room, and may be easily photographed.

NEW!

The only scope with a memory.



MEMO-SCOPE

Memo-Scope is available in two models: Portable (Model 103), and Rack Mounted (Model 103-R).

Plug-in vertical amplifiers of a variety of characteristics are available to increase flexibility. Hinged camera mount swings photographic apparatus aside for direct-display view.

TYPICAL APPLICATIONS

Study of transient electrical phenomena as short as 10 microseconds in duration.

Presentation of tube or transistor characteristics without the necessity of repetition.

Display of frequency response curves without the need of a sweep generator.

Spectrum analyses.

Shock testing.

Electrocardiographic studies.

Detection and measurement of relay bounce or contact noise.

High-speed X-Y plotting.

Investigation of transient behavior of power supply regulation.

Camera shutter timing.

CONDENSED SPECIFICATIONS

5-INCH MEMOTRON STORAGE TUBE

Erasure: internal waveform generator triggered by a push button or by application of a 25-volt, 1-millisecond positive external pulse, erases stored traces within 250 milliseconds.

DC Blanking: CRT grid direct coupled to external or internal blanking gate allows beam to be turned off except during sweep and insures constant sweep-time intensity.

Deflection Plates: available at rear terminal strip for direct connection.

AMPLIFIERS

Frequency Response: DC to 250 kilocycles within 10%.

Rise Time: 2 microseconds.

TRIGGERED LINEAR SWEEP

Range: 10 μsec to 10 seconds per division, adjustable continuously or in 18 calibrated steps.

Trigger: vertical amplifier signal, AC line or external pulse, either polarity, DC or AC coupled. Minimum external trigger amplitude, 0.1 volts.

Ready Light: neon lamp indicates sweep is at left side of screen, ready for trigger.

AMPLITUDE CALIBRATOR

Available at front panel terminal—one kilocycle square wave with peak-to-peak amplitude of 0.01, 0.1, 1.0 or 10 volts, within 3%.

BEAM POSITION INDICATORS

Four neon lamps show position of writing beam when not on screen.

ILLUMINATED GRATICULE

Illuminated scale calibrated in 1/3" squares in 10 × 10 array.

RACK MOUNTING

Model 103-R available on standard 14" × 19" relay rack panel.

DIMENSIONS

13" wide, 14" high, 20" deep. Etched circuit epon-glass electrical chassis.

For additional information on Memo-Scope

HUGHES PRODUCTS

A DIVISION OF THE HUGHES AIRCRAFT COMPANY

write to: HUGHES PRODUCTS · ELECTRON TUBE

International Airport Station, Los Angeles 45, California

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Want more information? Use post card on last page.

Kollsman PRECISION

system tested in our own instruments . . .

now available for industrial control engineering . . .

A KOLLSMAN type 2103 B – 0460
size 11 – input 115 v. 400 cps.
high torque to inertia ratio
other windings available

KOLLSMAN INDUCTION MOTORS
. . . feature high torque to inertia ratio

Miniature two phase squirrel cage rotor units for standard inputs of 400 or 60 cps. Excellent linearity in torque vs. control phase voltage, and torque vs. speed. Also, high torque to inertia ratio. Many units can be supplied with precision Kollsman integral gear heads in ratios as high as 1 : 78,000. Center tap windings and many other variations available to meet your design needs.

The servo components shown here—some exclusive, many with extraordinary performance characteristics—are designed and produced to fill the exacting needs of our own instruments to provide automatic control of flight and other functions associated with aircraft. They are now available as basic elements to aid in solving your control problem.

For nearly 30 years Kollsman has been gaining in authority and in reputation for research, development and production of accurate and reliable instruments and controls. No matter how severe your requirements—ask Kollsman first.

Security regulations do not permit us to publish material on our classified projects, of which there are many.

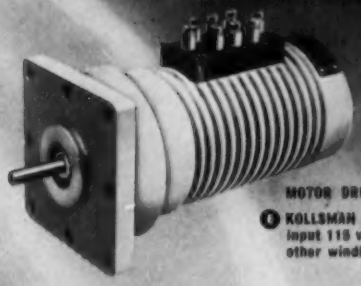
TELL US THE PERFORMANCE YOU WANT
. . . we are research and development specialists in designing to order and in assisting you to solve your control engineering problems.

CAREER OPPORTUNITIES

We have openings for mechanical and electromechanical engineers and senior technicians. Write us if interested.

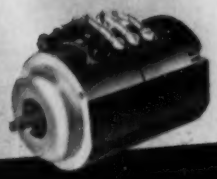
CIRCUITROL
C KOLLSMAN type 974 F-0164
input 115 v., 60 cps.
other windings available

INDUCTION GENERATOR
D KOLLSMAN type 945B—04602
400 cps.
other windings available



MOTOR DRIVEN GENERATOR
E KOLLSMAN type 1381—0460322
input 115 v., 400 cps.
other windings available

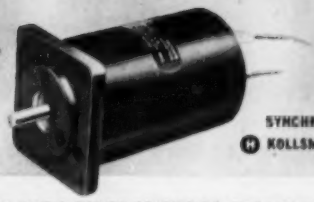
PERMANENT MAGNET GENERATOR
F KOLLSMAN type 944C-0126204



SYNCHRONOUS DIFFERENTIAL
G KOLLSMAN type 1121B-0119
input 26 v., 0-400 cps.
other windings available

rotating equipment

proven in aircraft and missiles . . .



SYNCHRONOUS MOTOR
H KOLLSMAN type 13900—0460

D KOLLSMAN SYNCHROTELS: Function as a low-torque control transformer or inductive pickoff. The movable element of the Synchrotel can be coupled directly to the most sensitive instrument to convert, with a high degree of accuracy, the instrument movement into electrical signals. The Synchrotel may be coupled to any low-torque shaft, such as a gyro gimbal shaft, whose angular position is to be transmitted. Weight: 3 ounces. For use at 60, 400 and 1,000 cycles.

C KOLLSMAN CIRCUITROLS: High precision synchros for use as control transformers, differentials, resolvers, phase-shifters, or phase angle indicators. Available in sizes 23, 17 and 15 frames. With polyphase or single phase stator or rotor as the application demands. Can be designed to perform satisfactorily over a wide range of voltages and frequencies.

D KOLLSMAN INDUCTION GENERATORS: (1) For use as a system stabilizer in a closed-loop servo-mechanism, (2) for velocity damping in a positional servo system, (3) for acceleration measurements. All Kollsman Induction Generators are compensated to reduce residual voltage to a minimum—thus enlarging the scope of their application. A complete, up-to-the-minute range of units available.

E KOLLSMAN MOTOR DRIVEN GENERATORS: Designed with modular units for complete interchangeability. Because of this feature almost any Kollsman motor and any Kollsman generator of the same frame size can be made up as a motor driven induction generator. Further, integral gear trains can be supplied with ratios up to 1 : 78,000.

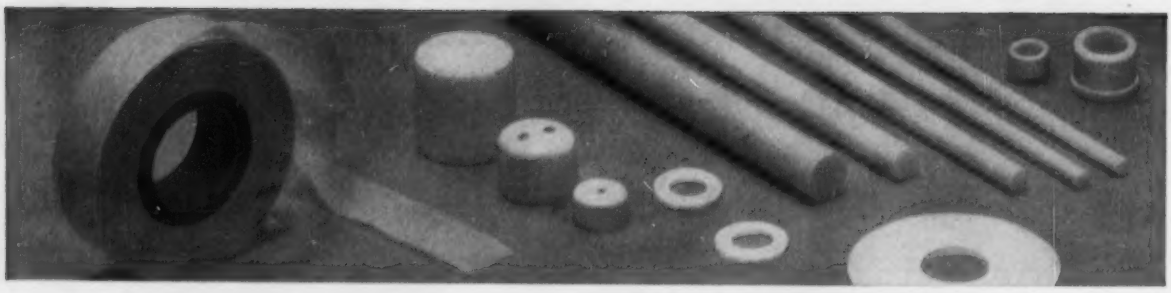
F KOLLSMAN PERMANENT MAGNET GENERATORS: Recommended as phase reference, potential or sinusoidal waveform sources. Such AC sources may be used advantageously in electronic equipment. All rotors are made of seasoned Alnico and most types are equipped with ball bearings.

G KOLLSMAN SYNCHRONOUS MOTORS: A hysteresis type motor in which **H** torque remains relatively constant as speed accelerates from zero. In a variety of sizes down to a frame diameter of 0.980 inch. Many models with integral gear heads with ratios up to 1 : 78,000. Kollsman Synchronous Motors are sensitive to frequency change, the slightest variation affecting the speed. Two such units, mated as a half-speed synchroscope, with an unusually efficient gearing system provide a unique control package—the Kollsman Synchronous Differential. Its output shaft rotates at half the difference between the speeds of the two synchronous motors, and provides usable torque!

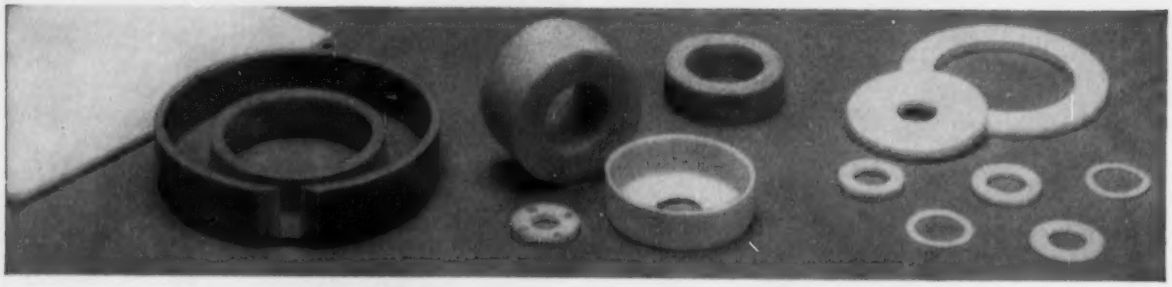
kollsman INSTRUMENT CORPORATION

KOLLSMAN PRODUCES: Flight Instruments • Precision Computers and Components • Engine Instruments • Optical Systems and Components • Navigation Instruments • Precision Flight Controls • Motors and Synchros • Precision Test Instruments for Aviation and Industrial Laboratories

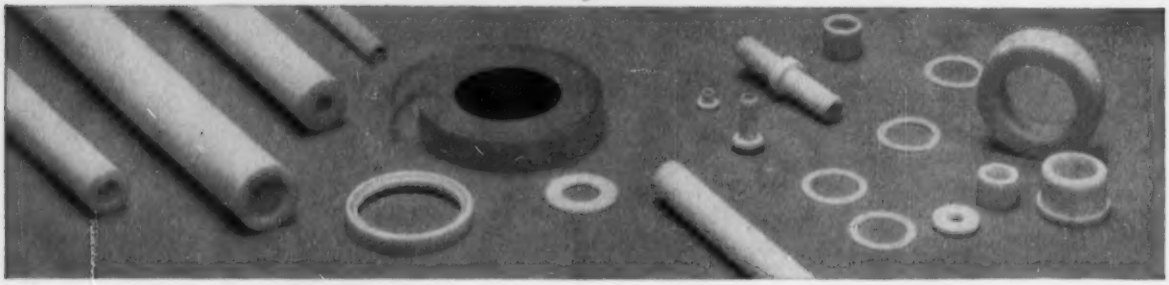
80-08 45th AVE., ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF *Standard* COIL PRODUCTS CO. INC.



DON'T GIVE UP WITHOUT TRYING



AN R/M Teflon* PRODUCT



What are you striving for—product improvement?—better equipment performance?—a more economical process? A product made of "Teflon" by R/M could well be the missing link you're seeking. For R/M has been working with this wonder plastic ever since it was produced and, with it, has solved some of the very toughest problems encountered in recent years by electrical and electronics engineers.

It is quite conceivable that R/M has already faced your particular problem and come up with a solution to it. So take advantage of the skill, experience and unmatched help that R/M can offer you. The many different products pictured indicate R/M's versatility in "Teflon" manufacture. We can fabricate to your own specifications or supply you with "Teflon" in the form of rods, sheets, tubes or tape in 13 colors conforming to military standard color code. For further information, write today.

Properties of "Teflon": High dielectric strength • Moisture absorption zero • Unaffected by weather • Excellent heat stability up to 500° F. in continuous operation • As tape, leaves no carbon residue along the discharge path • High impact resistance • Nonadhesive • Stretches easily • Tensile strength 1500-2500 psi. **Du Pont trademark*

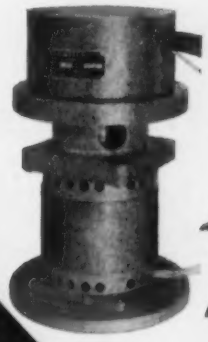
RM

RAYBESTOS-MANHATTAN, INC.

PLASTIC PRODUCTS DIVISION, Manheim, Pa.

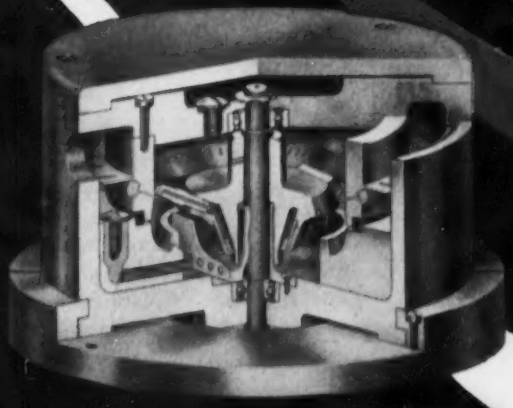
FACTORIES: Manheim, Pa. • Bridgeport, Conn. • No. Charleston, S.C. • Passaic, N.J. • Neenah, Wis. • Crawfordsville, Ind. • Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Asbestos Textiles • Laundry Pads and Covers • Packings • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose Rubber Covered Equipment • Industrial Rubber, Engineered Plastic, and Sintered Metal Products • Abrasive and Diamond Wheels • Bowling Balls



NEW SWITCH

for high-speed commutating—



The mercury jet

DELTASWITCH

no contact bounce • long life

Unique multi-position rotary switch for data sampling where application demands high speed (as many as 10,000 samples per second), long life and low noise. Ideal for thermocouple sampling and strain gauge monitoring to a high-speed analog to digital converter or oscilloscope display.

Deltaswitch utilizes rotating jet of mercury to connect sequentially each of many stationary contacts through low-resistance path to a common pole — no brushes or slip rings. Operates satisfactorily from 1,200 to at least 6,000 rpm. Contact resistance approximately .25 ohm. Noise levels of less than 10 microvolts in most applications. Flexible dwell time.

Copyright 1956 by Detroit Controls Corp.

NC NORWOOD CONTROLS

HIGH reliability
LOW maintenance

NORWOOD CONTROLS
UNIT OF DETROIT CONTROLS CORPORATION
935 Washington St. - Norwood, Mass.

Complete technical information available upon request.

VARISTORS

1. Reduction of arcing at relay or motor governor contacts.
2. Stabilization of rectifier circuits by limitation of peak voltage.
3. Voltage control in electronic circuits.
4. Protection of solenoids in direct current circuits.

THERMISTORS

1. Temperature control.
2. Temperature compensation.
3. Time delay.
4. Surge suppression.

ONE SOURCE

for **ALL** *your*

CERAMIC RESISTOR REQUIREMENTS...

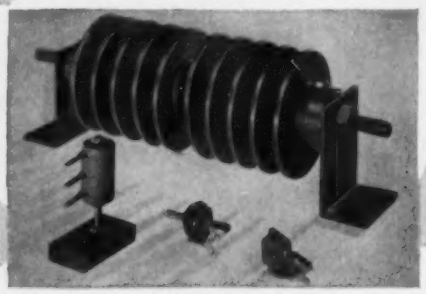
Globar®

NON-INDUCTIVE HIGH WATTAGE FIXED RESISTORS

1. Antenna terminators.
2. Dummy antennas.
3. Parasitic oscillator suppressors.
4. Power resistors for applications such as radio transmitters and inductive heating units.

COMPLETE ASSEMBLIES

of GLOBAR® Ceramic Resistors... like these recent designs... are engineered by Globar resistor specialists to meet the particular electrical, thermal and packaging requirements of *your* circuit.



OVER THIRTY YEARS of experience in the development and manufacture of special-characteristic Ceramic Resistors, plus complete engineering facilities and an experienced engineering staff, are at your service to solve your special resistor requirement problems.

A GLOBAR DIVISION Sales Engineer will be glad to discuss your application. Or send details of your problem direct. Write Globar Division, The Carborundum Company, Dept. E 87-636, Niagara Falls, New York.

Globar® Ceramic Resistors

by **CARBORUNDUM**

REGISTERED TRADE MARK

87-636

Transitron

SILICON VOLTAGE REGULATORS

UP TO 50 ma

Type	Voltage Range (volts)	Maximum Average Current ma at 25°C	Maximum Average Current ma at 125°C	Maximum Dynamic Resistance (ohms)
SV-5	4.3 - 5.4	50	10	55
SV-6	5.2 - 6.4	40	8	20
SV-7	6.2 - 8.0	30	6	10
SV-9	7.5 - 10.0	25	5	20
SV-11	9.0 - 12.0	20	4	70
SV-13	11.0 - 14.5	17	3.4	100
SV-15	13.5 - 18.0	14	2.8	120
SV-18	17.0 - 21.0	12	2.4	200

UP TO 150 ma

SV-804	4.3 - 5.4	150	30	55
SV-805	5.2 - 6.4	120	24	20
SV-806	6.2 - 8.0	90	18	10
SV-808	7.5 - 10.0	75	15	20
SV-810	9.0 - 12.0	60	12	70
SV-812	11.0 - 14.5	50	10	100
SV-815	13.5 - 18.0	40	8	120
SV-818	17.0 - 21.0	35	7	200

UP TO 2 AMPS

		(amps)	(ma)	
SV-904	4.3 - 5.4	2.0	400	2
SV-905	5.2 - 6.4	1.6	320	2
SV-906	6.2 - 8.0	1.2	240	2
SV-908	7.5 - 10.0	1.0	200	2
SV-910	9.0 - 12.0	.8	160	2
SV-912	11.0 - 14.5	.7	140	4
SV-915	13.5 - 18.0	.6	120	6
SV-918	17.0 - 21.0	.5	100	8

Transitron's silicon voltage regulators (sometimes called Zener diodes) are constant voltage elements for control and similiar circuitry. They provide excellent regulation and stability over a wide operating range.

Through improved thermal design, each of the three regulator series will give high load currents in the smallest possible size. The subminiature glass types, for example, provide twice the current in less than half the size of conventional regulators. High power types can be used to simplify circuits and eliminate amplification stages.

Inquiries are invited on higher voltage regulators, and precision, temperature compensated voltage reference elements.

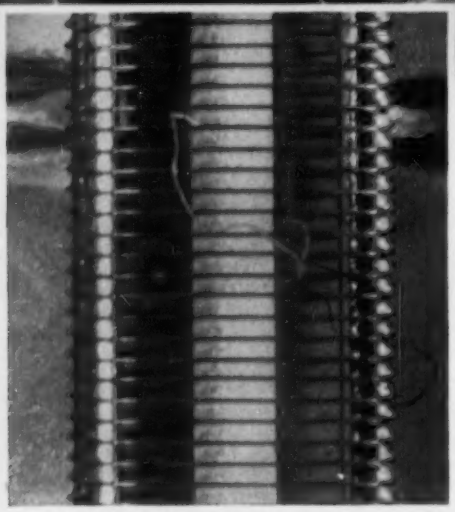
SEND FOR BULLETIN TE 1352

Transitron

electronic corporation • wakefield, massachusetts

Germanium Diodes | Transistors | Silicon Diodes | Silicon Rectifiers

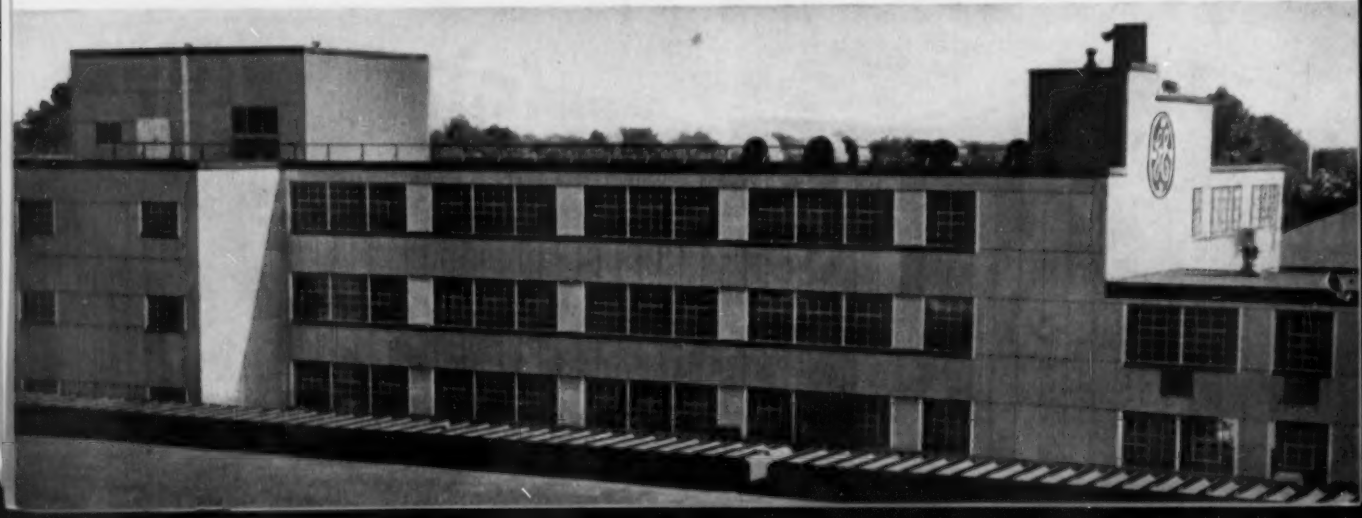
▲ **MANUFACTURED "UNDER GLASS"!** For optimum cleanliness, 6829's are assembled under glass-paneled protective hoods. All G-E employees who build 5-Star Tubes wear rubber finger cots, and their uniforms are lint-free Nylon and Dacron. These precautions are taken to ward off lint and dust, most frequent causes of intermittent tube "shorts".



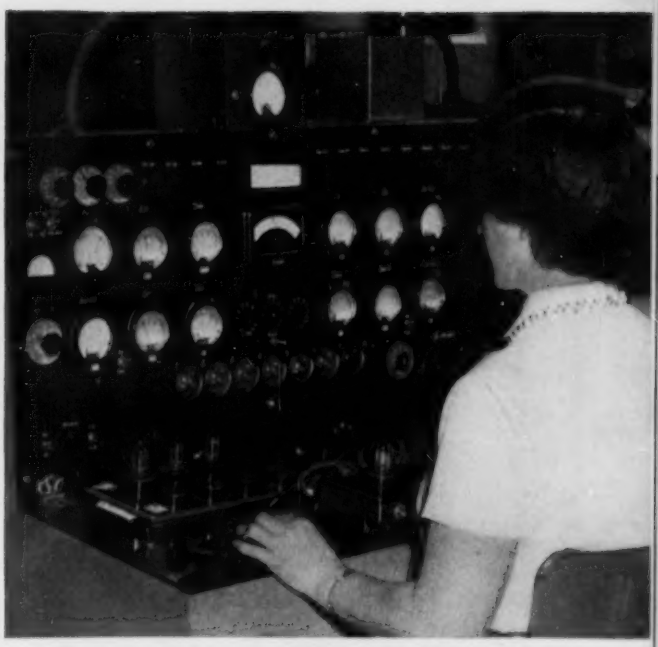
▲ **LINT IS A TROUBLE-MAKER!** The unretouched micro-photo above shows a strand of lint which easily can cause an inter-electrode short-circuit. Dust particles within a tube have the same harmful effect.

FIRST GENERAL ELECTRIC HAS LINT-FREE

▼ **1200 WORKERS ASSEMBLE 6829's AND OTHER HIGH-RELIABILITY TUBES** in this 5-Star building, located apart from the rest of G.E.'s Owensboro, Ky., tube factory. Because of the special white lintless uniforms, plus immaculately clean working conditions, "Operation Snow White" is aptly used to describe G-E 5-Star Tube manufacture. The entire assembly and inspection area is pressurized, with air that has been filtered, dehumidified and cooled.



▲ **SPECIALLY TESTED . . . BIASED TO CUT-OFF FOR LONG INTERVALS!** Life tests of G-E computer tubes under cut-off conditions, are made in order to be sure no "sleeping sickness", or failure to respond to grid input pulses, develops during inactivity. This is determined by means of periodic interface checks.



▲ **CHECKED FOR COMPUTER-SERVICE CHARACTERISTICS!** G-E computer tubes are specifically tested for those electrical qualities that closely affect tube operation in computer circuits. Among the characteristics checked are zero-bias plate current . . . cut-off performance . . . difference in cut-off between both triode sections.

5-STAR COMPUTER TUBE MANUFACTURE FOR ADDED RELIABILITY

Shock-resistant design—comprehensive cut-off tests—further establish Type 6829 as the most trustworthy tube you can apply in military computers!

General Electric, first to design and build a new line of tubes for computers, now pioneers the first 5-Star high-reliability tube for computer circuits—analog and binary—where airborne, gunnery, or field-transport conditions call for resistance to mechanical shock and vibration.

Type 6829 has the many 5-Star design features that give added strength, such as a compact, sturdy tube cage . . . double mica spacers . . . a double-staked getter. In addition, tube assembly is carried on in immaculate surroundings free from lint and dust, while special tests assure those electrical qualities that are essential in achieving computer dependability.

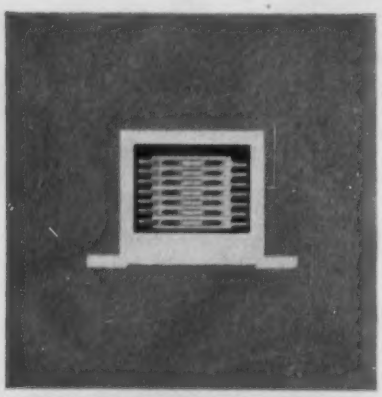
A 9-pin miniature, the 5-Star 6829 has similar characteristics to standard computer Type 5965. The new tube is designed for high-speed circuits—has high perveance, balanced, sharp cut-off qualities, and low heater power requirement (.45 amp).

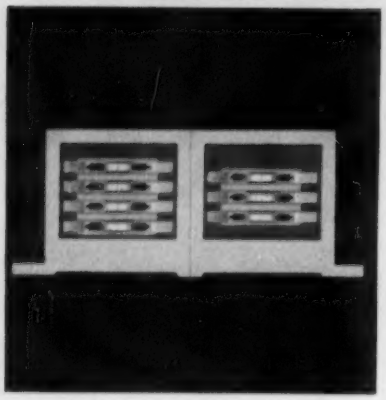
Get the complete performance story! Write to *General Electric Company, Electronic Components Division, Schenectady 5, New York.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

162-101





SINGLE STACK versus INTERLEAVED HEADS

for magnetic tape DATA recording

A lively controversy has raged for years over the question, "Are two heads better than one?" Davies, a supplier of both single-stack and *interleaved heads finds use for both, and presents a method for choosing the best for your applications.*

The original single track recording head left little room for choice or controversy. But as tracks multiplied, and the heads were stacked, troubles developed. More tracks per inch required thinner heads and closer head spacing. But closer head spacing in analog recording increased the intertrack crosstalk. Wider intertrack shielding had to be used, thereby defeating the original need.

Interleaved heads seemed to be the answer. The tracks per head were halved by alternating them on two heads, and mounting the heads side-by-side. Crosstalk became less important for there was no longer a tight limit on shielding width.

Interleaved heads performed handsomely until applied to really precise data work. In aircraft and missile testing, for example, the wave shape on one track is often important only as it relates to wave shapes on other tracks. Unfortunately, time and phase coincidence among tracks is the one thing that interleaved tracks on two heads *can not* provide. By recording a given number of tracks with a single stack head on wider tape, far less phase error is experienced than with interleaved tracks on narrow tape. Thus the pendulum has swung back toward single stack heads, with the proviso that individual heads in the stack be precisely aligned. Typical specifications require that all gaps lie between two straight lines 0.0002″ apart, assuring less than 0.2 mil total scatter.

On the basis of proved operating characteristics, these guides have been found extremely useful in finding the right head for a given application:

USE SINGLE STACK HEADS WHEN *time and phase coincidence among tracks are at all important, for in such work precisely aligned single stack heads are absolutely essential. Even when track-jamming is necessary, modern intertrack shielding in a well designed system can reduce crosstalk to a minimum factor.*

USE INTERLEAVED HEADS WHEN *it is essential that a very large number of tracks must be recorded, and considerable time and phase displacement among them can be tolerated, or when compatibility with other equipment using interleaved heads is necessary.*

In digital recording there never has been any controversy. For one thing, crosstalk is not so much of a problem. For another, time and phase coincidence have always been of the utmost importance. If interleaved tracks in two separate heads are used, even the slightest tape stretch or shrinkage between recording and playback completely destroys coincidence of pulses across the tape.

Whichever side of the fence you're on, you're sure to find considerable use for the detailed coverage of the entire head situation given in Bulletin 3301, "Multi-Track Record/Reproduce Heads." Write Davies for your copy.

LABORATORIES, INCORPORATED
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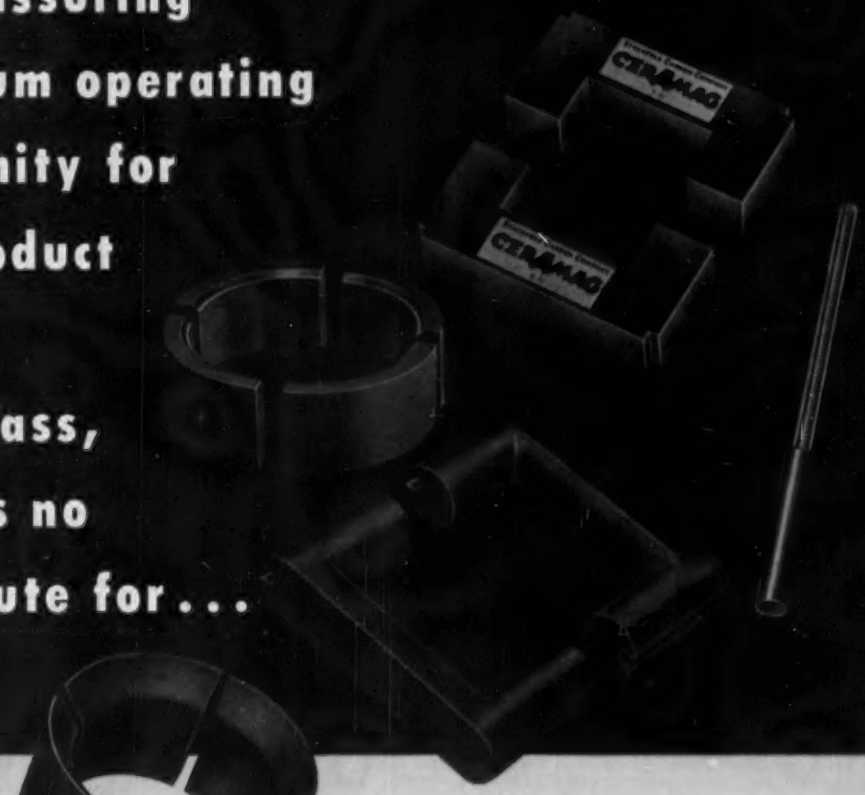
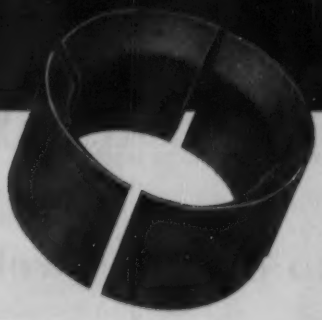
WEBSTER 5-2700

for critical uses . . .
or for assuring
maximum operating
uniformity for
any product
in any
price class,
there is no
substitute for . . .

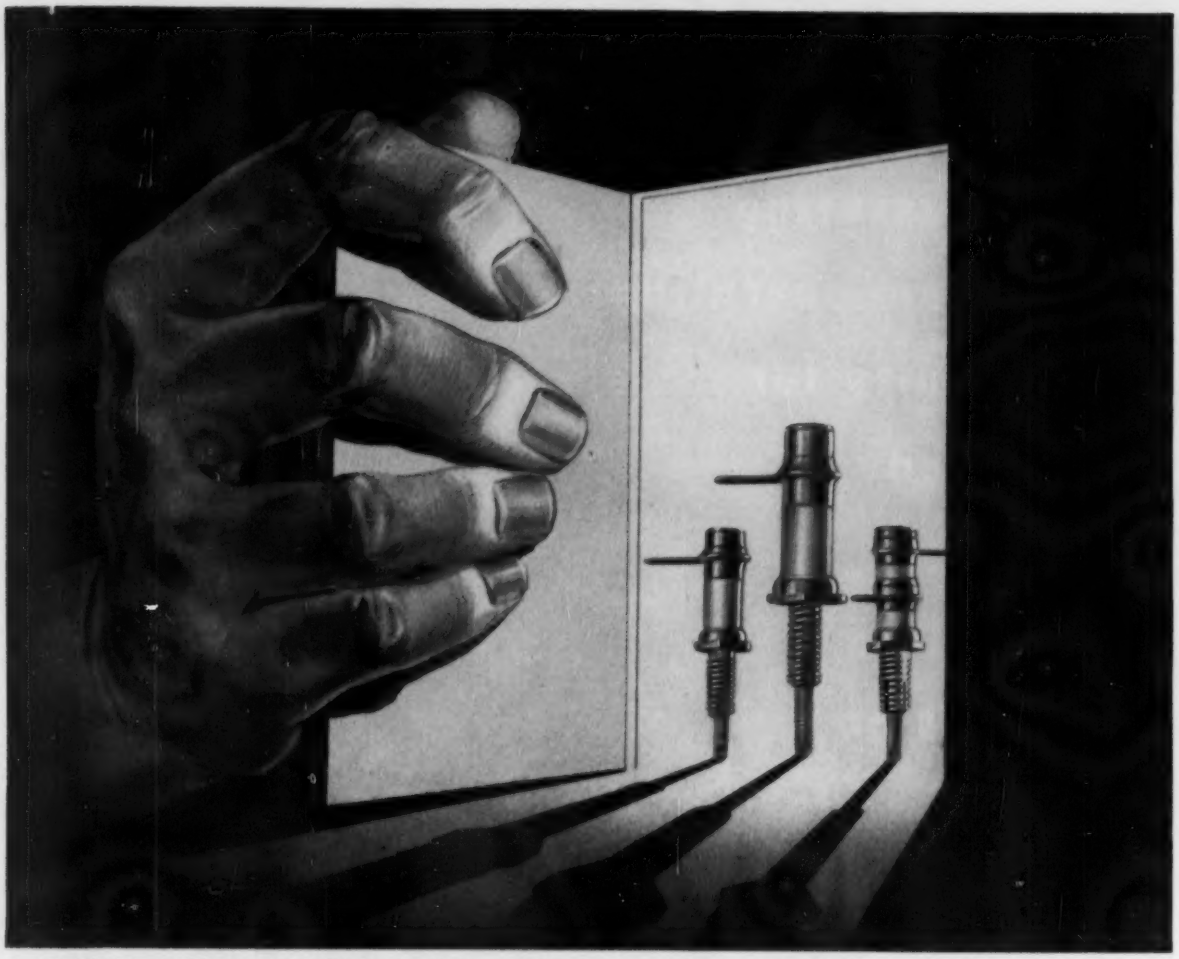




The sample matches the specifications . . . and each subsequent production unit is exactly like the sample . . . *electrically and mechanically.*

STACKPOLE
Ceramag®
FERROMAGNETIC CORES

Electronic Components Division, STACKPOLE CARBON COMPANY, *St. Marys, Pa.*



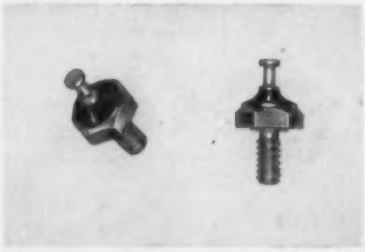
CTC Capacitor Data: Metallized ceramic forms CST-50, in range 1.5 to 12.5 MMFD's; CST-6, in range 0.5 to 4.5 MMFD's; CS6-6, in range 1 to 8 MMFD's; CS6-50, in range 3 to 25 MMFD's; CST-50-D, a differential capacitor, with the top half in range 1.5 to 10 MMFD's and lower half in range 5 to 10 MMFD's.

These Midgets do big jobs well

These capacitors outperform capacitors several times their size. Their tunable elements virtually eliminate losses due to air dielectric, resulting in wide minimum to maximum capacity ranges. The tuning sleeves are at ground potential, and can be locked firmly to eliminate undesirable capacity change.

Every manufacturing detail has to conform to the highest quality control standards. Because of these standards, CTC can guarantee the performance of this family, and of every electronic component CTC makes.

Other precision-made CTC components that benefit from CTC high quality standards include terminals, terminal boards, swagers, hardware, insulated terminals and coil forms. For all specifications and prices, write Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge 38, Mass. On the West Coast contact E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles 16, and 61 Renato Court, Redwood City, California.



New Series X2122 Stand-Off Capacitors with ceramic dielectric are exceptionally rugged. These are general RF by-pass capacitors for use in high quality electronic equipment. The encapsulating resin provides rigidity and durability under extreme conditions of shock, vibration, and humidity. Over-all height mounted is under ¾". Available in a range of values.

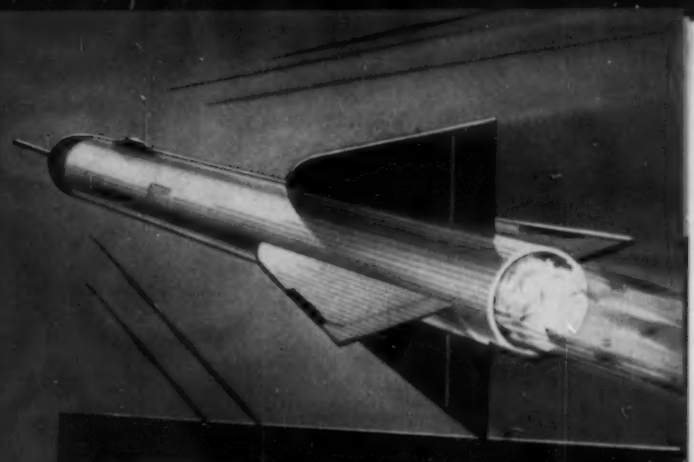
CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components custom or standard

Now Available!

PHILCO Silicon Transistors



With These Outstanding Advantages:

- Excellent performance at Temperatures from −60°C to +140°C
- Collector Saturation Voltage of 0.1 Volt or Under
- Maximum Frequency of Oscillation in the 15 Megacycle Range.

Unmatched performance and reliability! Characteristics *assured* by extensive life tests under typical operating conditions. Philco PNP Silicon Transistors make practical *complete transistorization* of military and commercial circuits *—where high ambient temperatures are encountered.*

Philco Silicon Transistors are now in pilot production and immediately available for initial design work. Specify Type T-1025 for amplifier, oscillator and low level general purpose applications and Type T-1159 for high speed switching applications.

FEATURES

• HIGH TEMPERATURE PERFORMANCE • VERY LOW LEAKAGE CURRENT • HIGH SPEED • SUITABLE FOR DIRECT COUPLING • LOW SATURATION VOLTAGE • ABSOLUTE HERMETIC SEAL

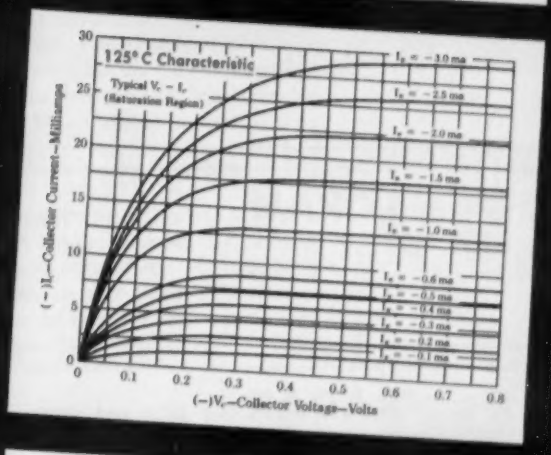
Make Philco your prime source of information on Silicon Transistor Applications.

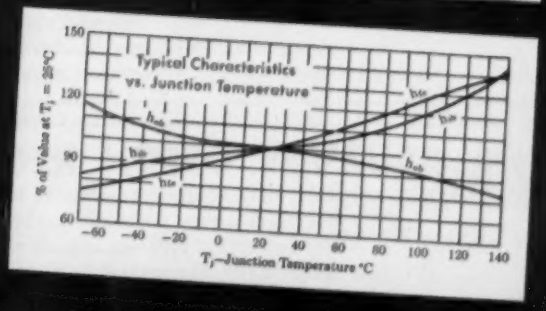
Write to Dept. E, Lansdale Tube Company Division, Lansdale, Penna.

Characteristics of Types T-1025 and T-1159
(T_a = 25°C)

Characteristic	Condition	Typical Value
Current Amplification Factor, h_{fe}	$V_{CB} = -6$ v $I_E = -1$ ma	18
Output Capacitance, C_{ob}	$V_{CB} = -6$ v $I_E = -1$ ma	7 μμf
Maximum Oscillation Frequency, $f_{max.}$	$V_C = -6$ v $I_E = -1$ ma	15 mc
Cutoff Current, I_{CBO} or I_{EBO}	V_{CB} or $V_{EB} = -10$ v	.001 μa

Maximum Power Dissipation—150 mw
Maximum Collector Voltage—T-1025-25 v
T-1159-10 v





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LANSDALE TUBE COMPANY DIVISION

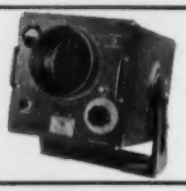
LANSDALE, PENNSYLVANIA

Superior

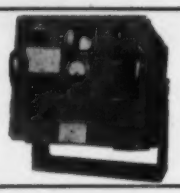
MARINE ELECTRONIC EQUIPMENT

by EDO

EDO DEEP DEPTH SOUNDER Sonar unit in wide Navy use, now available commercially. Gives clear indication of depth on CRT in two scales: 0-100 feet; 0-100 fathoms. Records continuously in three scales: 0-600 feet; 0-600 fathoms; 0-6,000 fathoms.

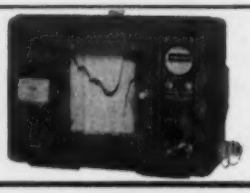


EDO FISHSCOPE Most advanced fish finding device on the market, available in three versions for deep and shallow fishing. Spots fish on CRT at depths to 400 fathoms, then magnifies any 10-fathom sector 20 to 40 times for clearer view. Compact design, single transsducer.



EDO LORAN Compact, direct-reading aid to long-range navigation. No special training required to operate. Fix obtained from single, 28-tube unit in matter of seconds, regardless of weather or sea conditions. Absolutely accurate though relatively low in cost.

EDO RADAR For long and short-range navigation in any weather. CRT display gives clear picture on 1, 2, 5, 10 and 20-mile range. Patented slotted waveguide antenna, mounted on transmitter, assures superior definition. Ideal where space and generator capacity are limited.



EDO SURVEY DEPTH RECORDER

Extremely accurate equipment for measuring depth of water for survey purposes. Legible, permanent record of depth, 0 to 250 fathoms, is made within eight overlapping range scales. For permanent or temporary installation.

EDO CORPORATION • COLLEGE POINT, L. I., N. Y. Since 1925

from OAK's great store of switch tooling

countless switching combinations can be readily built

In producing over 250,000,000 switches in over 70,000 varieties for manufacturers of electronics, OAK has developed the world's most extensive inventory of tooling for switch making.

An OAK switch can be designed for every low capacity application, and produced in most cases from existing tooling . . . your assurance of best possible delivery service.

Whatever your switch application, greater engineering experience and production facilities will work for you when you bring your switching problems to OAK.

***We invite your inquiry** regarding rotary, slider, rotary slider, pushbutton, plug or snap switches . . . simple or complex, commercial or military.*

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also manufacturers of OAK tuners, vibrators, choppers and other electro-mechanical devices.

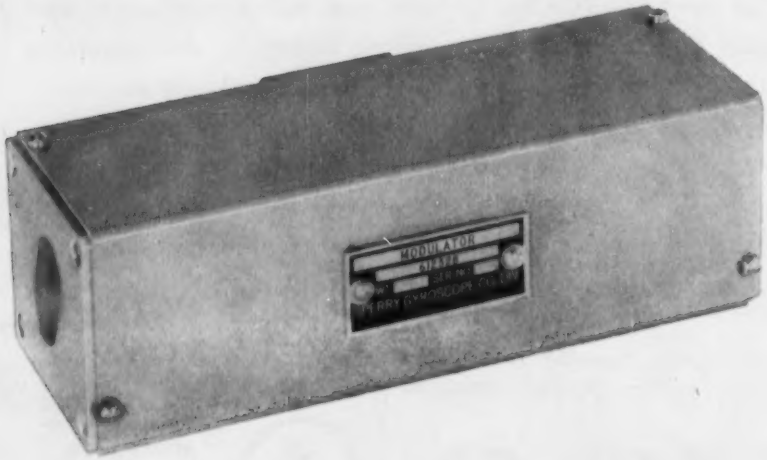
in waveguide...

Isolators Single, compact units combine best features previously exhibited only by very narrow band components. Designed for operation at very high power levels into severe load-impedance mismatches without deterioration in electrical characteristics.

Attenuators Miniaturized designs produced for severe space, weight, and drive power limitations. Remotely actuated current varies attenuation without moving parts.

Introducing

New Microwave



Modulators Faraday rotation devices originally designed and produced to simulate a nutating radar beam. Ruggedized units satisfy MIL T-945A.

in coaxial line...

Isolators *First* nonreciprocal ferrite devices designed in coaxial line – for narrow or extremely broad band applications.

FERRITE Devices

Coaxial-Line Isolators and other ferrite units shown here represent new devices just introduced by Sperry's Microwave Electronics Division for advanced electronic systems in the 1 to 40 kmc range. These new components result from an intensive research and development program and have made possible important advances in many Sperry systems. Now Sperry has concentrated in its Microwave Electronics Division specialized engineering knowledge and facilities for production of a large variety of advanced ferrite devices.

You can see more of these devices in a new brochure which is yours for the asking. For assistance in applying these versatile devices, consult engineers of the Microwave Electronics Division. Telephone or write directly to this division in Great Neck, N. Y.

SPERRY
Microwave Electronics Division
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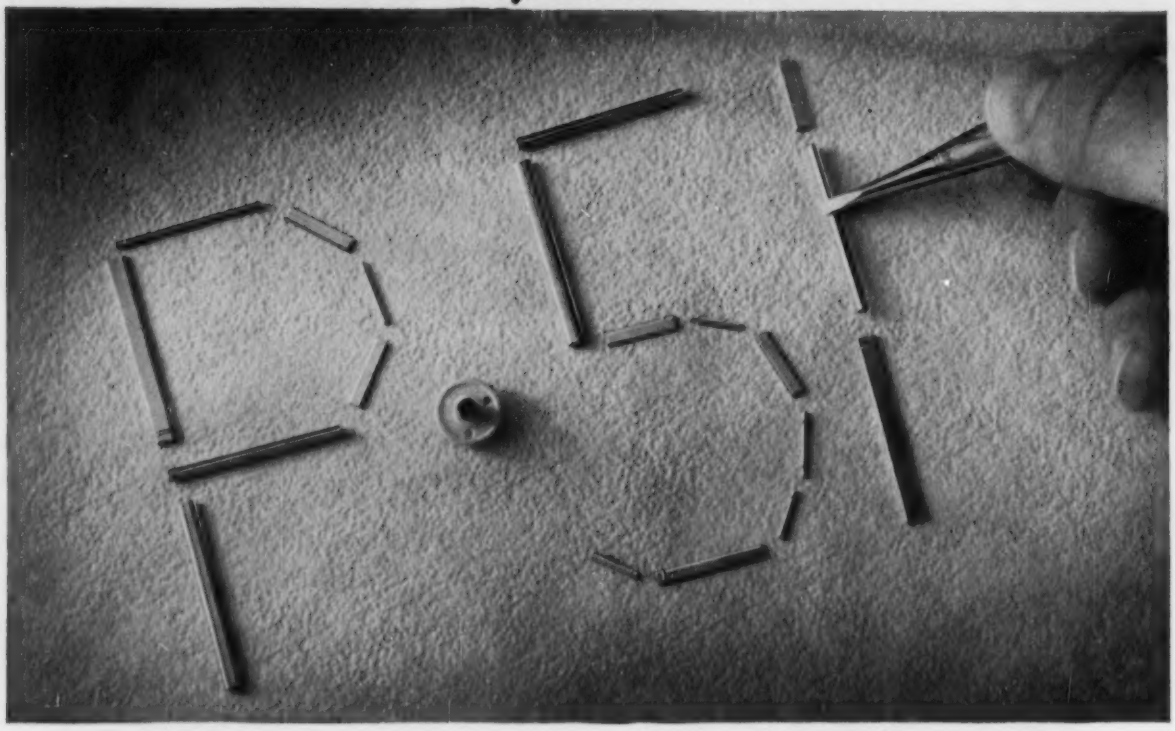
Want more information? Use post card on last page.

Now - Stronger Passive Cathodes!



Superior announces Cathaloy P-51

— a new passive cathode material

- *100% stronger than Cathaloy P-50, ideal for ruggedized tubes*
- *Free of sublimation and grid emission troubles; low interface impedance*
- *Available in seamless, Weldrawn® and Lockseam* forms*

Latest addition to Superior Tube's family of Cathaloys is Cathaloy P-51 —a passive cathode material with entirely new properties.

NEW INGREDIENT

Cathaloy P-51 is similar to Cathaloy P-50 in chemical composition and electrical characteristics. But the addition of approximately 4% tungsten greatly increases its strength.

HIGH HOT STRENGTH

Tests prove that Cathaloy P-51 is twice as strong as Cathaloy P-50 at operating temperatures. This means it is especially useful in ruggedized tubes. In all tubes, it reduces the risk of failure from shock and of bowing. As with all Cathaloys, the composition of Cathaloy P-51 is carefully controlled by Superior. Every melt is checked in an electron tube before being approved for production.

UPGRADE YOUR TUBES

Cathodes made from Cathaloy P-51 are available in either seamless, Weldrawn or Lockseam form, and can be fabricated to your exact dimensional specifications. Write for technical information. Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.

*Manufactured under U.S. patents.

NOTE. Cathaloy is a trademark of Superior Tube Co., Reg. U.S. Pat. Off.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

Johnson & Hoffman Mfg. Corp., Mineola, N. Y.—an affiliated company making precision metal stampings and deep-drawn parts

our leadership protects yours...

It takes a lot of doing to produce the exact same thing over and over again hundreds of thousands of times—without slipping up on a thousandth of an inch, watt, or milligram. This insistence on *uniformity* has helped build our reputation as the world's most Consistently Dependable producer of CAPACITORS. Continuously uniform production is a science —one that we've painstakingly pursued since 1910.

Typical of the "countless" C-D electrolytics used by major equipment manufacturers the world over are:

"EC" MINIATURIZED CERAMIC CASED TUBULARS For cramped-space applications in hearing aids, transistorized devices, and remote control assemblies. Less than ¼" D., only ¾" L.

"NL" ULTRA-SMALL Hermetically sealed aluminum cased electrolytics, built for compactness, ruggedness, low leakage, long shelf and in-use life.

TANTALUM 3 tubular types, all with low power-factor, moisture-impervious hermetic seal, long service and especially long shelf life. "TX" with sintered anode; "TAN" miniature foil type; sub-miniature, low-voltage wire anode type "NT".

TYPE "UP" Made in the smallest tubular aluminum cans possible for any given capacity and voltage combination. In single, dual, triple and quadruple capacity combinations.

Write for catalog to Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

CONSISTENT HI-DEPENDABILITY

CORNELL-DUBILIER CAPACITORS

SOUTH PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER & CAMBRIDGE, MASS.; PROVIDENCE & HOPE VALLEY, R. I.; INDIANAPOLIS, IND.; SANFORD, FUQUAY SPRINGS & VARINA, N. C.; VENICE, CALIF.; & SUB.: THE RADIART CORP., CLEVELAND, OHIO; CORNELL-DUBILIER ELECTRIC INTERNATIONAL, N. Y.

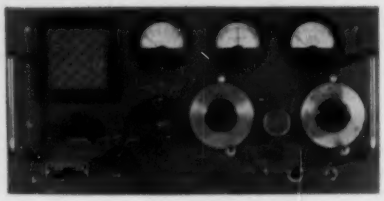
Want more information? Use post card on last page.

SPECIAL PURPOSE RECEIVERS

BY

NEMS-CLARKE

The recognized leader in the design and production of Special Purpose Receivers, NEMS-CLARKE presents here a few of the instruments now being used by industry and government. We have a receiver to meet your requirements, whether it be for laboratory applications, telemetry reception, propagation study, guided missile monitoring, radiosonde reception, television and sound rebroadcasting or as a general communication receiver where superior performance is desired.



TYPE 1400

CRYSTAL CONTROLLED FM.....215-245 Mcs

IF BANDWIDTH.....Wide band—500 Kc bandwidth at 3 db points. Attenuation ± 500 Kc from center frequency greater than 60 db. Narrow band — 100 Kc bandwidth at 3 db points. Attenuation ± 250 Kc from center frequency greater than 60 db.

FREQUENCY DEVIATION METER.....Peak reading over frequency range from 400 to 80,000 CPS. Three scales 25, 75 and 150 Kc.

TYPE 1701

FM .....55-260 Mcs

BANDWIDTH .....2 Mcs

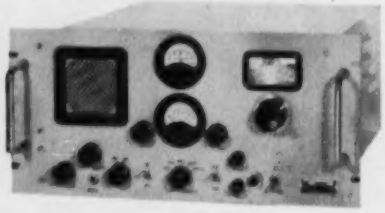
TYPE 1302

AM, FM or CW.....55-260 Mcs

IF BANDWIDTHS.....300 Kcs and 10 Kcs

SQUELCH.....Operates on monitor circuit

VIDEO RESPONSE VARIABLE FROM 1 Kc to 300 Kcs

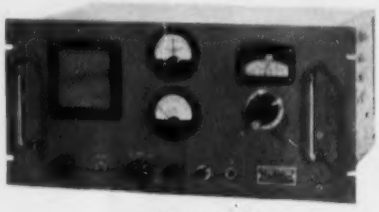


TYPE 1502

AM, FM or CW.....55-260 Mcs

IF BANDWIDTH.....300 Kcs

SQUELCH: BUILT-IN LOW NOISE PREAMP



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FM .....55-260 Mcs or 175-260 Mcs

BANDWIDTH .....500 Kcs or 300 Kcs

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BANDWIDTH .....10 Mcs

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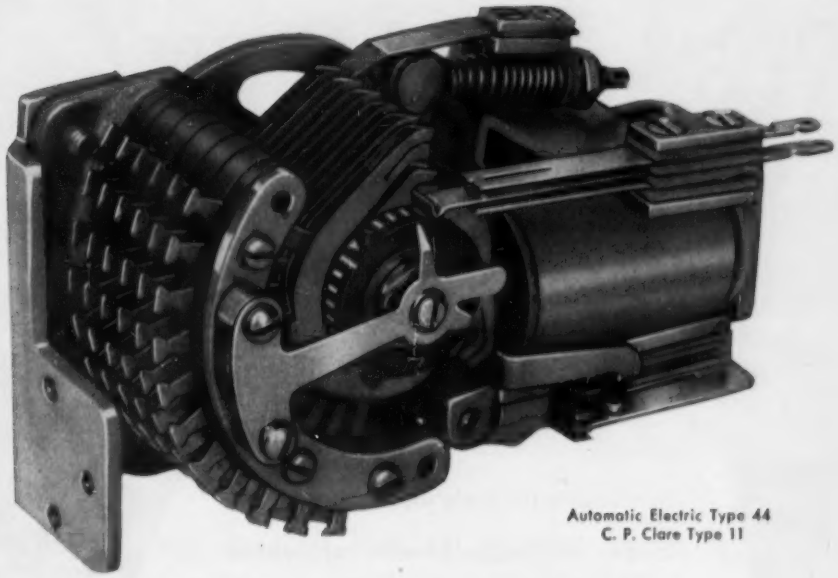

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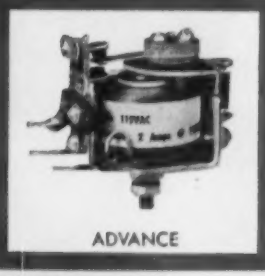
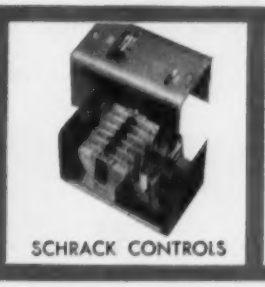
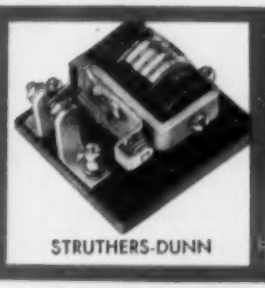


ADVANCE



SCHRACK CONTROLS



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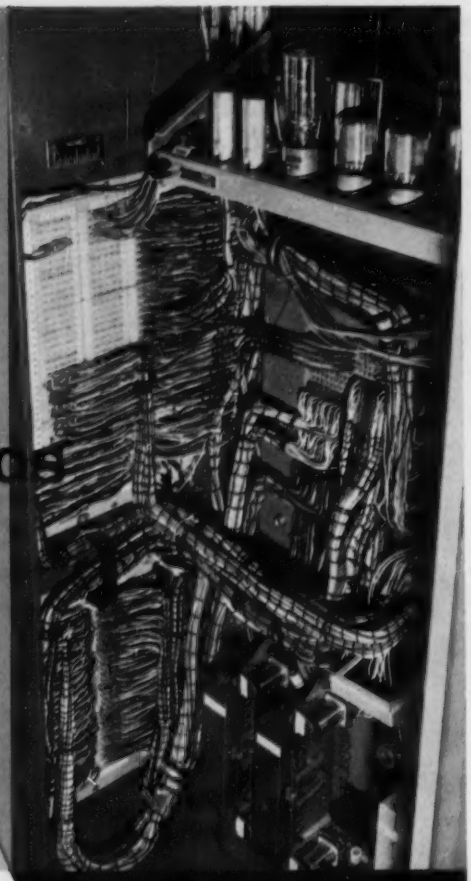

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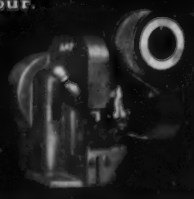

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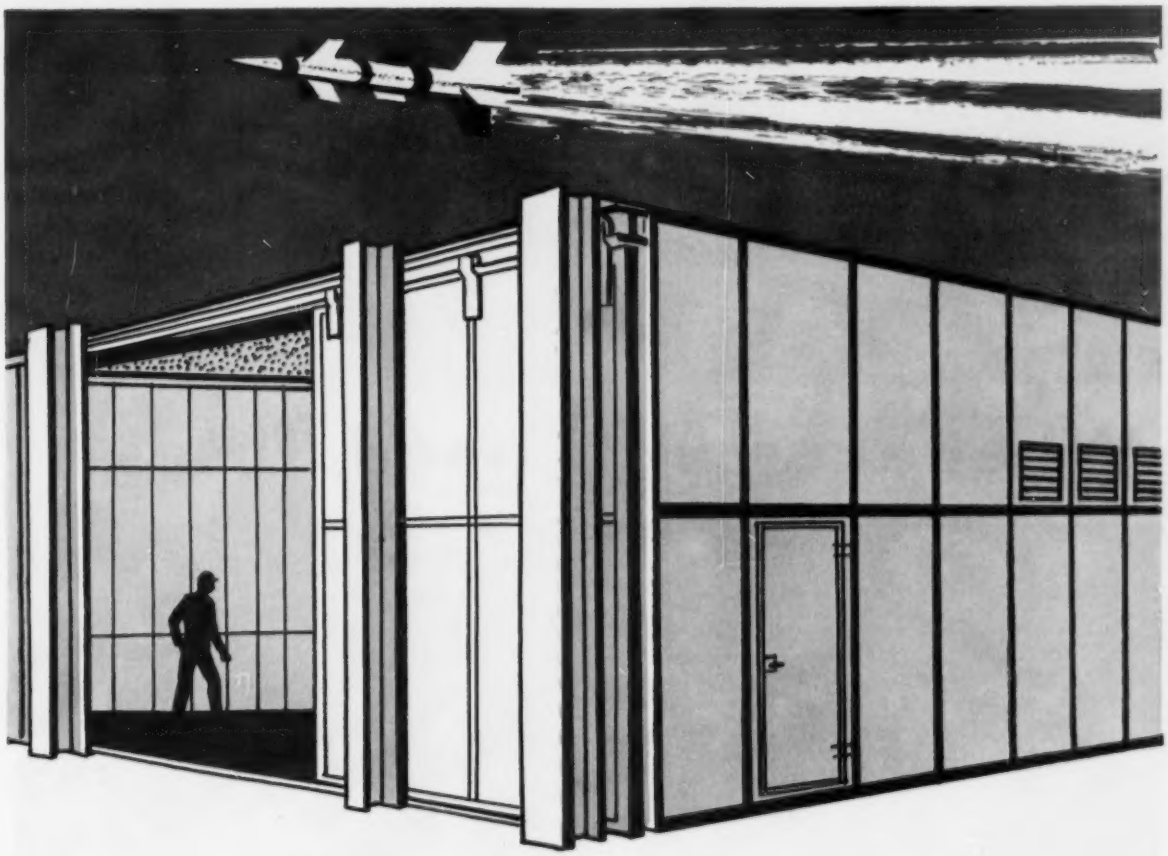

HUGE ENCLOSURE SHIELDS GUIDED MISSILES FOR RADIO-FREQUENCY TESTS AT BELL

Current F.C.C. regulations governing radio-frequency interference give much publicity to the need for adequate shielding. But an even greater need arises from those who must conduct electronic tests *without interference from external sources.*

This was the need at Bell Aircraft Corporation, Buffalo, N. Y. But further, Bell asked ACE to design, build, and install an enclosure large enough to shield a guided missile in its entirety. The result is the largest prefabricated shielded enclosure ever built.

This gigantic shield measures 40 feet long, 35 feet wide, and stands 18 feet high. Made of ACE prefabricated panels of galvanized sheet steel, the entire structure can be taken down, moved, and reassembled at another location if necessary. Yet it provides the high levels of attenuation required to test aircraft electronic equipment for conformance with all military interference specifications.

Other unique features include electrically controlled sliding doors for maximum opening of 16 feet high by 21 feet wide . . . air operated contact fingers around the door periphery for positive r-f seal . . . two personnel access doors . . . air-conditioning . . . electric and pneumatic service entrances . . . 5000 watts of lighting . . . and a specially reinforced floor capable of supporting extremely heavy loads.

ACE can solve your shielding problems with comparable success — from small bench-size "boxes" to huge enclosures even larger than the Bell "hangar" described above—meeting all the varied requirements of industry, military, and medical work. An Ace sales engineer will be glad to show you how. Or, write for free catalog on ACE standard enclosures.

ACE **First and Finest in Shielded Enclosures**

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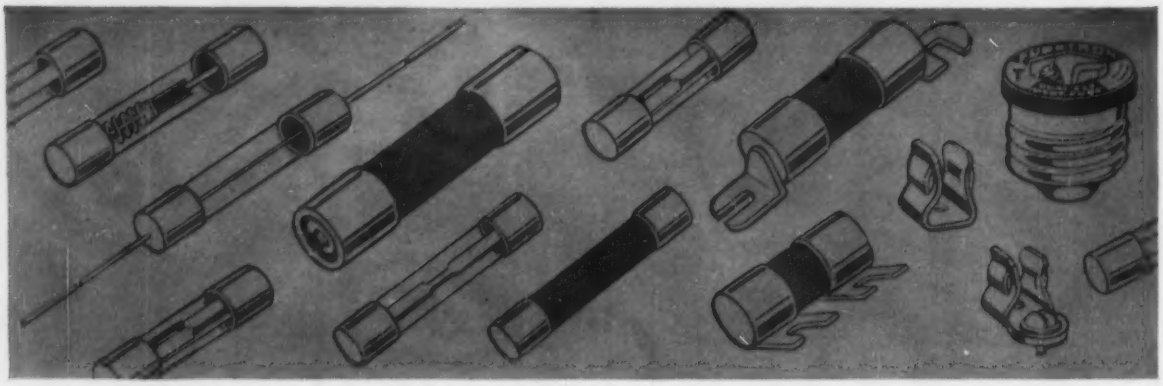
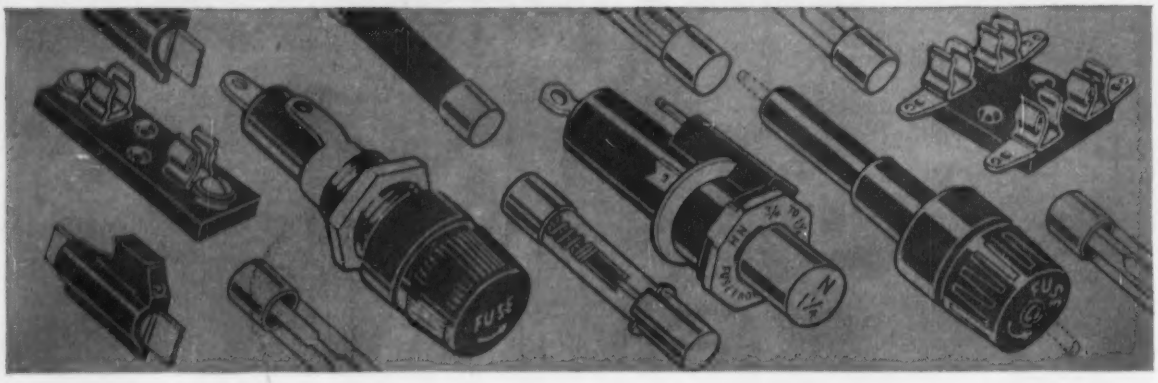


Whenever you need fuses...



you'll save time and trouble by turning FIRST to BUSS!

By relying on BUSS as your source for fuses, you can quickly and easily find the type and size fuse you need. The complete BUSS line of fuses includes: Standard types, dual-element (slow blowing), renewable and one-time types . . . in sizes from 1/500 amp. up—plus a companion line of fuse clips, blocks and holders.

BUSS fuses are made to protect—not to blow needlessly

When you specify BUSS fuses—users of your equipment receive maximum protection against damage due to electrical faults. And just as important, users are safeguarded against irritating, useless shutdowns caused by faulty fuses blowing needlessly.

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If you should have a special problem in electrical protection . . . the world's largest fuse research laboratory and its staff of engineers are at your service—backed by over 42 years of experience. Whenever possible, the fuse selected will be available in local wholesalers' stocks, so that your device can be easily serviced.

For more information on BUSS and Fusetron small dimension fuses and fuseholders... Write for bulletin SFB.

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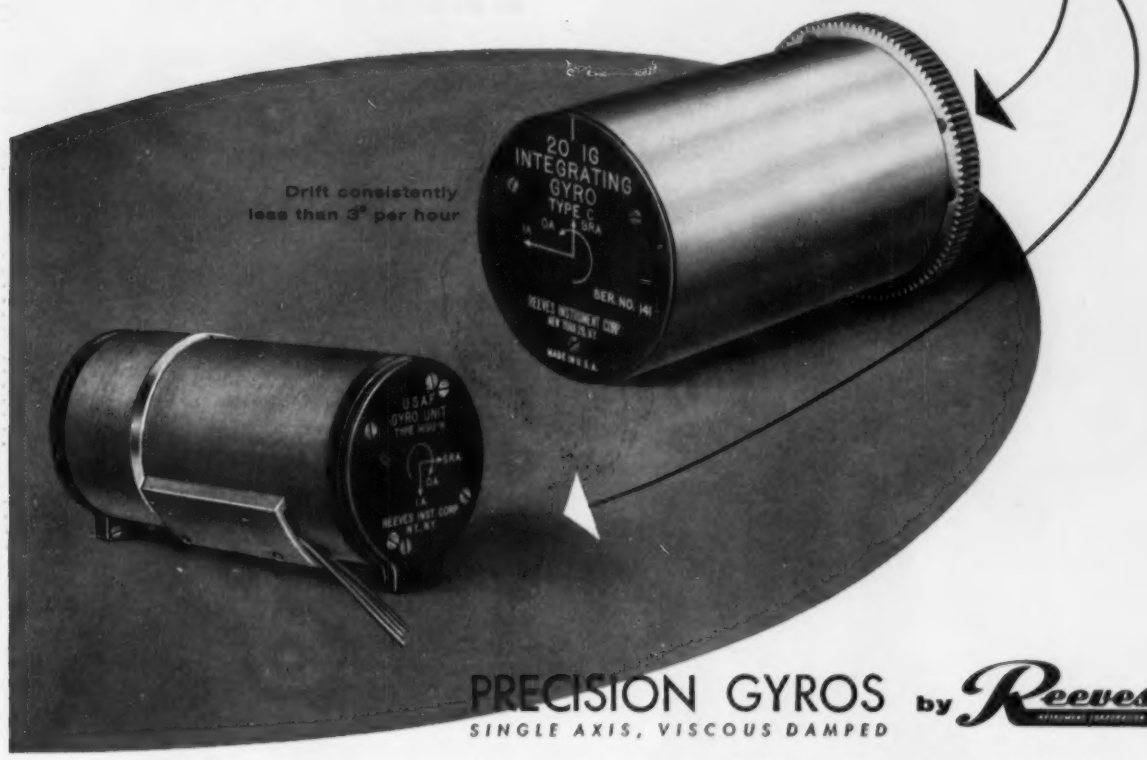

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No manufacturer can show a matching record of precision engineering achievement in this most exacting department . . . or better our record of PROVED service in the field. Reeves was one of the first to achieve quantity production to high precision standards of the HIG-5 Gyro . . . the "work-horse" of the gyro field.

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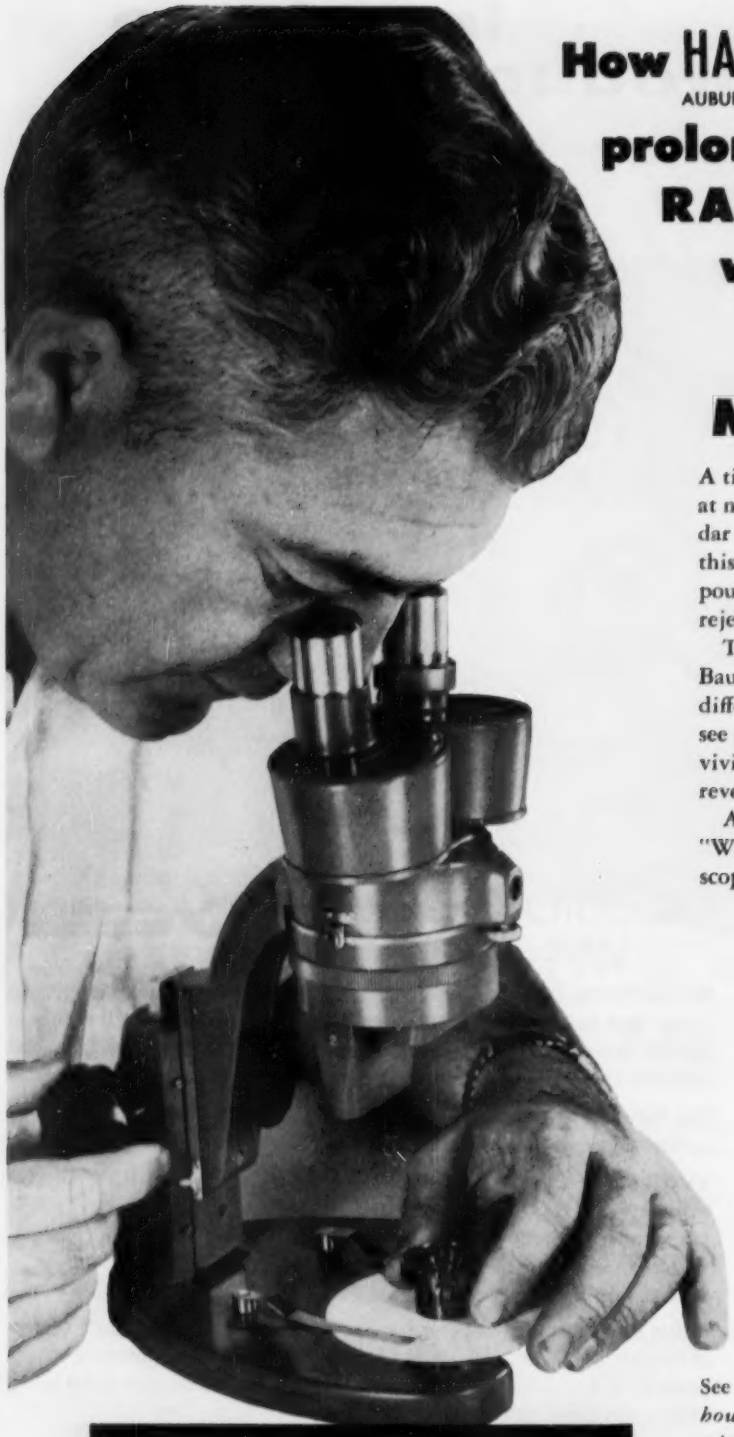


How HARRY WOLFF Co., Inc.,

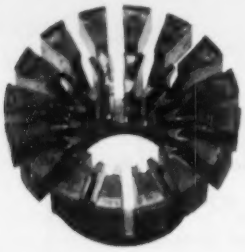
AUBURNDALE, MASSACHUSETTS

prolongs life of $5000 RADAR TUBES with 3-D MICRO-VISION

A tiny burr on this tuning crown will burn off at normal operating temperatures and cause radar tube failure. Precision components like this are made of metals that cost over $100 per pound. The tube costs up to $5000. Obviously, rejects and failures are prohibitively costly.

That's why Harry Wolff Co., Inc., uses Bausch & Lomb Stereomicroscopes to check 368 different edges of each tuning crown. Inspectors see the work right-side-up, clearly magnified in vivid 3-dimensional detail. Burrs are quickly revealed, and easily scraped off.

And that's why Harry Wolff, president, says: "We consider the B&L Wide Field Stereomicroscope as important to us as a precision lathe."



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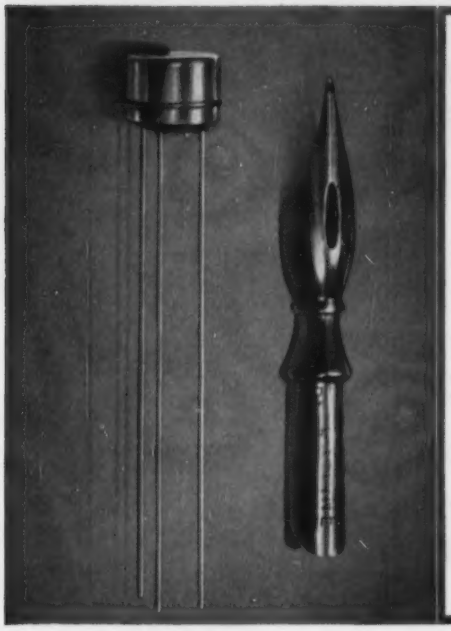
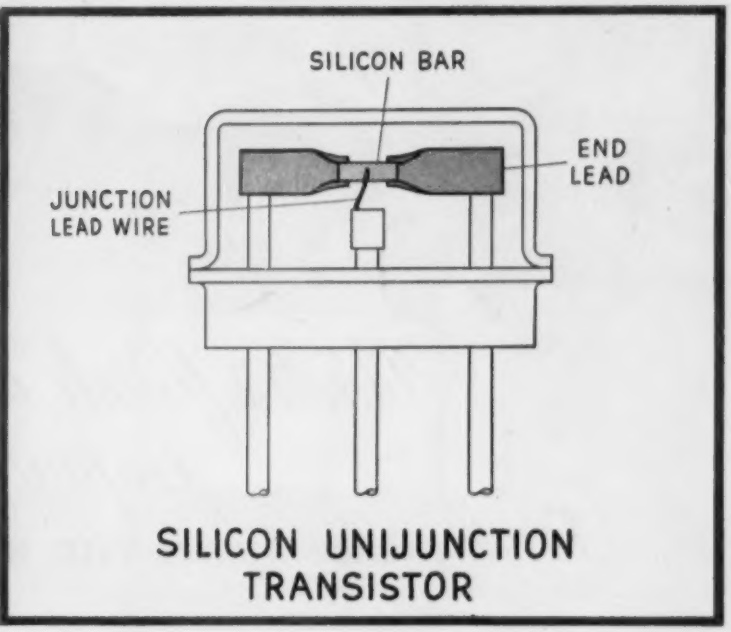
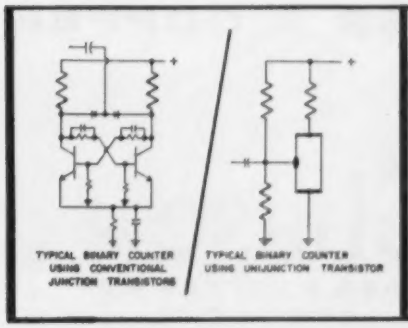
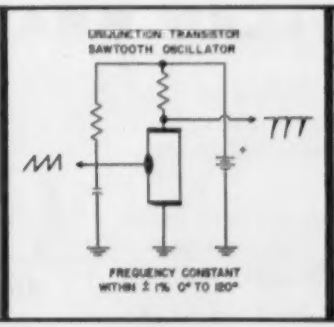


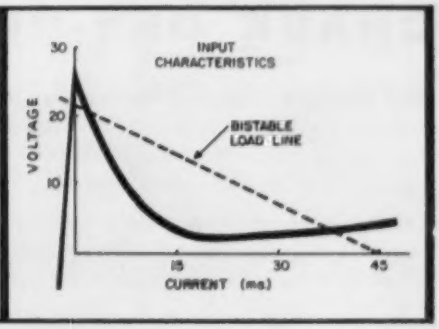


New General Electric Silicon Unijunction Transistor simplifies circuitry...improves reliability!

THIS single device, the new G-E Unijunction Transistor, does the work of two transistors and several other circuit components...reduces circuit complexity, improves reliability factors and leads to ultimate lower cost. Invented by General Electric and developed under Air Force contract, the new Unijunction Transistor combines the uniformity, stability, and reliability of a junction transistor with the desirable characteristics of point contact transistors. Its dependable high-temperature performance is commended for missile, electronic switching and relay applications. For further information on the Unijunction Transistor, call or write: *General Electric Co., Semiconductor Products Department, Section X4116, Electronics Park, Syracuse, New York.*


TYPICAL BINARY COUNTER USING CONVENTIONAL JUNCTION TRANSISTORS
TYPICAL BINARY COUNTER USING UNIJUNCTION TRANSISTOR





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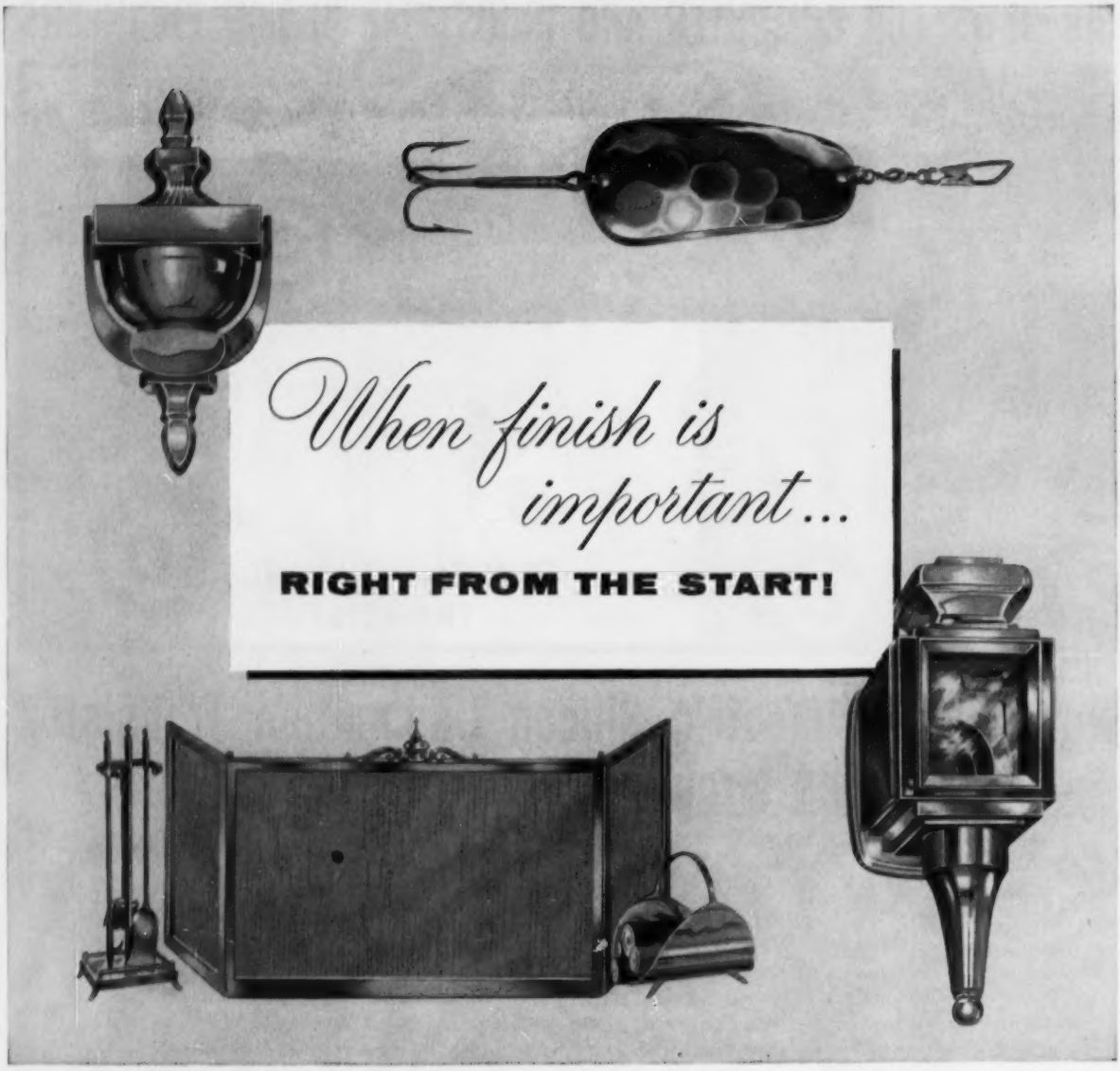

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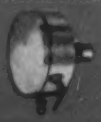
15/16" diameter composition	Hollow shaft twist ear mounted 15/16" diameter composition for screwdriver adjustment	Bushing mounted 15/16" diameter concentric tandem composition with SPST switch	15/16" diameter 1 watt composition
15/16" diameter composition with SPST switch	Twist ear mounted 15/16" diameter composition with flatted shaft for push-on knobs	Self-supporting snap-in mounted 15/16" diameter composition	15/16" diameter composition with waterseal between shaft and bushing and bushing and panel
1-1/8" diameter concentric tandem tone switch and composition variable resistor with SPST on-off switch	Twist ear mounted 15/16" diameter composition with SPST switch	Self-supporting snap-in bracket mounted 15/16" diameter composition with SPST switch	1-1/8" diameter composition
1-1/8" diameter composition with SPST switch	Twist ear mounted 15/16" diameter preset tandem	Self-supporting snap-in mounted compact 3-section multiple composition	1-1/8" diameter 2 watt composition
1-17/64" diameter 2 watt wirewound	Miniaturized clinch ear mounted composition	Miniaturized bushing mounted 3/4" diameter composition	1-17/64" diameter 2 watt wirewound with locking type bushing
 1-17/32" diameter 4 watt wirewound	Miniaturized clinch ear mounted composition with SPST switch	Terminals For Wire Wrapping Bushing mounted 15/16" diameter composition with SPST switch	1-17/32" diameter 4 watt wirewound

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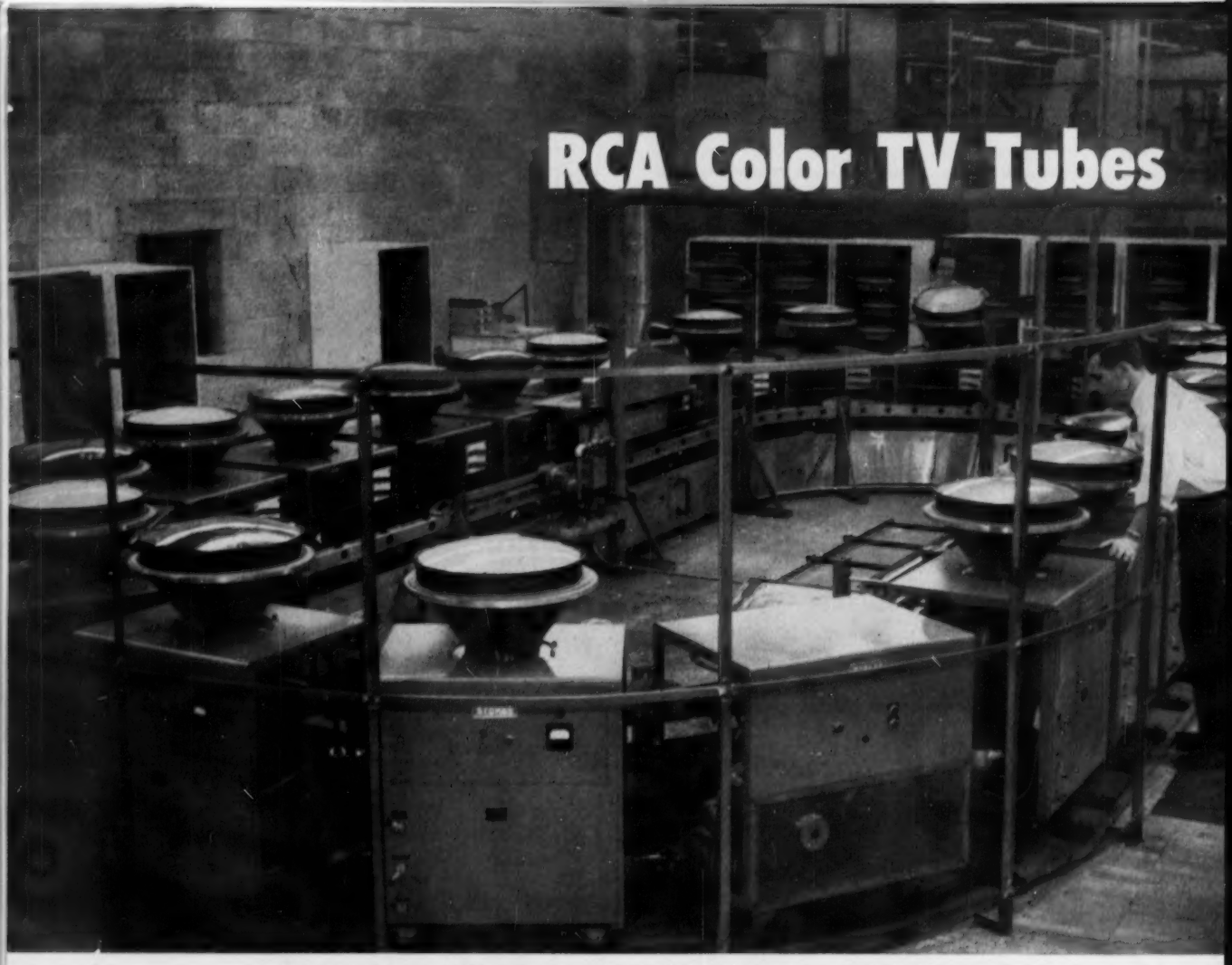
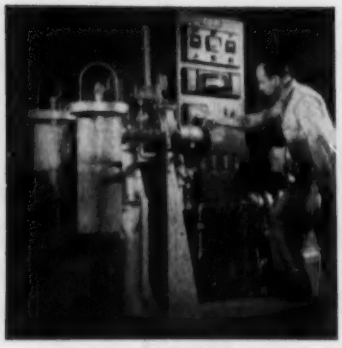


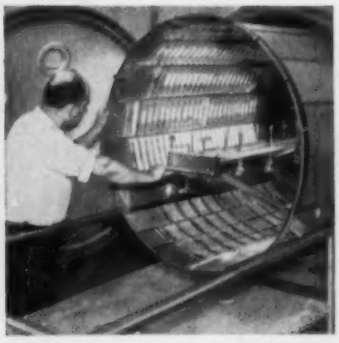
Automatic production at high output per man-hour is obtained from this complete in-line Stokes aluminizing system, used for color TV tube face plates at the RCA tube plant, Lancaster, Pa.

Electronic equipment manufacturers are profiting from other Stokes Vacuum Equipment...



Vacuum Metallizers. Stokes manufactures a complete line of vacuum metallizing equipment to plate selenium rectifiers, printed circuits and other conductive coatings on non-conductive materials.

Vacuum Impregnators. Manufacturers of electronic equipment use Stokes vacuum impregnation systems for obtaining improved characteristics of coils, capacitors and other components.



Vacuum Furnaces. Stokes melting and heat-treating furnaces permit electronic manufacturers to pre-process raw and semi-finished materials with less contamination, for increased life and performance.

Aluminized on Stokes high-production in-line system

The first continuous production installation for aluminizing color TV tube face plates is now operating at the RCA tube plant, Lancaster, Pa. — using a Stokes automatic in-line system.

APPLICATION to this unique tube design demonstrates the versatility that is characteristic of Stokes aluminizing systems. These systems are adaptable to all the television tube constructions . . . both for black and white and for color . . . that are now being used or developed in the industry. They are engineered to provide high output and flexibility to meet changes in production rates and tube sizes.

The combination of Stokes high speed "Ring-Jet" vapor pumps and mechanical forepumps gives rapid evacuation, short cycles and fast production. Systems are compact . . . require little floor space. Removable electrodes simplify filament replacement. Internal cooling coils reduce oil temperature rapidly in the booster pump before vacuum is released. Systems are available in a complete range of capacities and prices.

A Stokes engineer will be glad to talk over your specific tube production requirements. He is well qualified to apply Stokes' 30 years of experience in high vacuum engineering and automatic production techniques, to solve your problem on the most efficient and economical basis. For a consultation, or for literature useful in your own applications, write to Stokes today.

Exclusive Stokes twin-tube unit aluminizes two TV tubes at a time. These units can be furnished completely automatic or manually controlled, in-line or stationary . . . in a range of capacities to meet your requirements.

High Vacuum Equipment Division
F. J. STOKES CORPORATION
5517 Tabor Road, Philadelphia 20, Pa.

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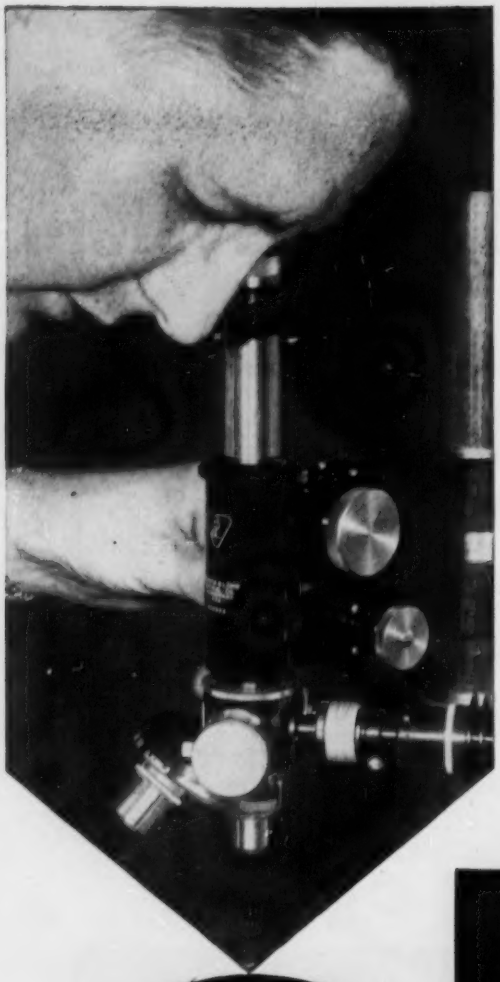


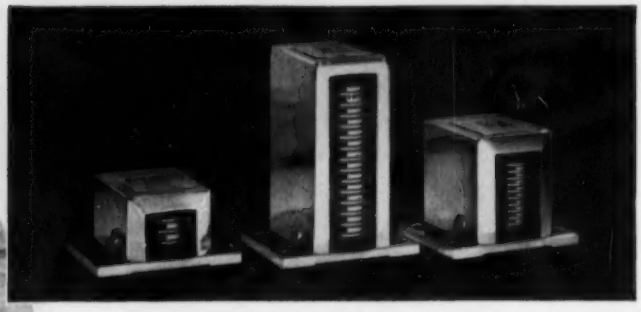
BRUSH *announces...*

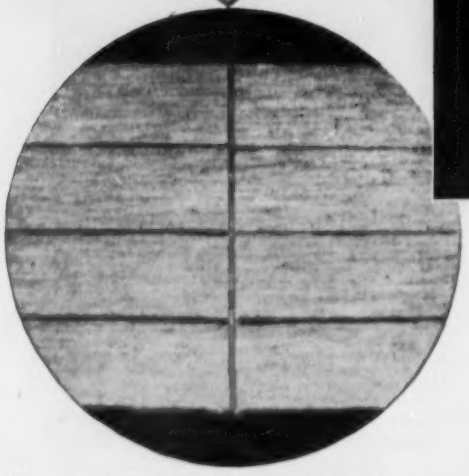
NEW PRECISION MAGNETIC HEADS FOR CRITICAL RECORDING APPLICATIONS

Brush now offers a new design concept in multi-channel magnetic heads which provides extremely close tolerances to assure accuracy in recording and reproduction. These heads have already been proven in exacting airborne and missile applications.

ADVANTAGES

- **Uniform output assured by close mechanical tolerances on track width and channel spacing ... ± .002 in. maximum.**
- **Channel-to-channel timing accuracy provided by precise gap alignment... ± .0001 in. maximum.**
- **Crosstalk minimized by full shielding.**
- **Sustained accuracy under severe operating conditions assured by our new construction techniques.**





400X enlargement shows high precision gap and track construction.

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Brush offers these heads in three designs: providing 7, 8, or 13 tracks per inch. Heads may be interlaced to provide up to 25 tracks per inch. Modifications or new designs using this construction technique may be made to your requirements. Consult Brush on your magnetic head needs—write Brush Electronics Company, Department K-110, 3405 Perkins Avenue, Cleveland 14, Ohio.

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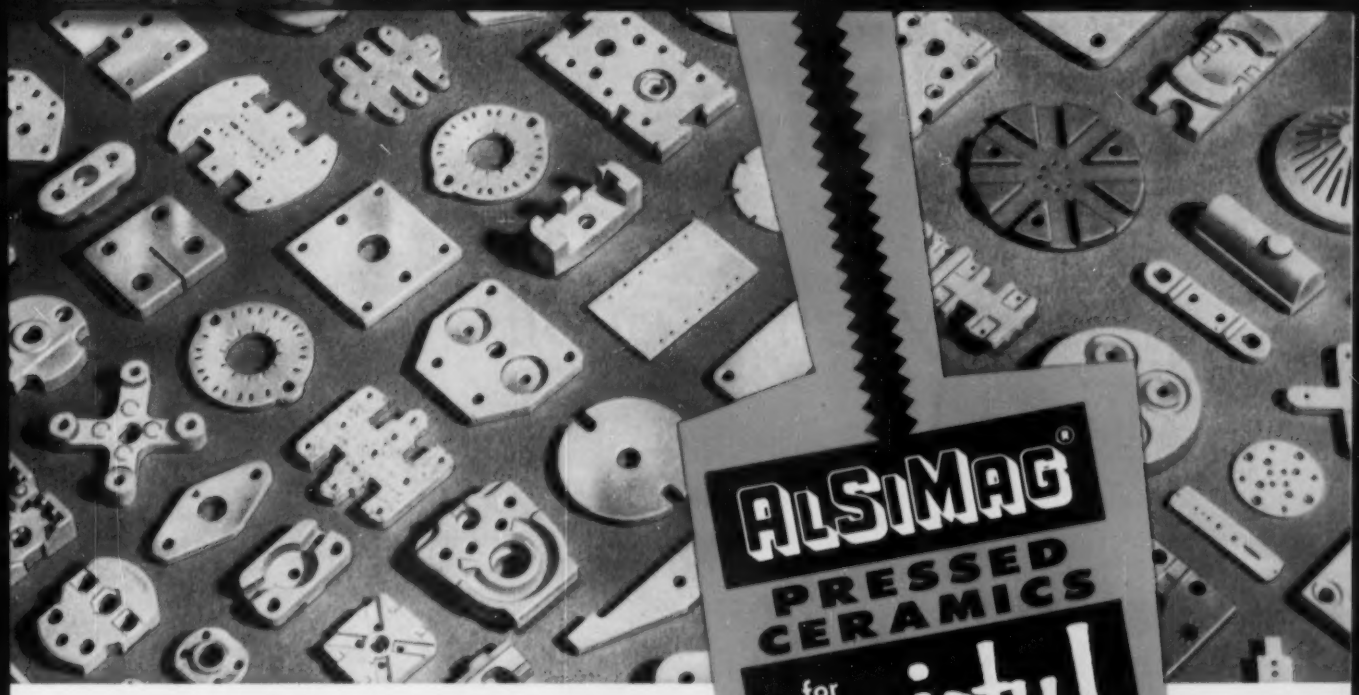

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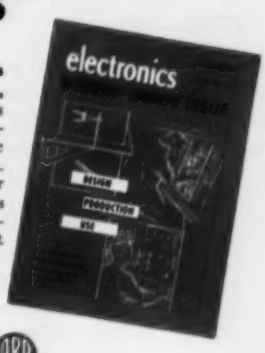

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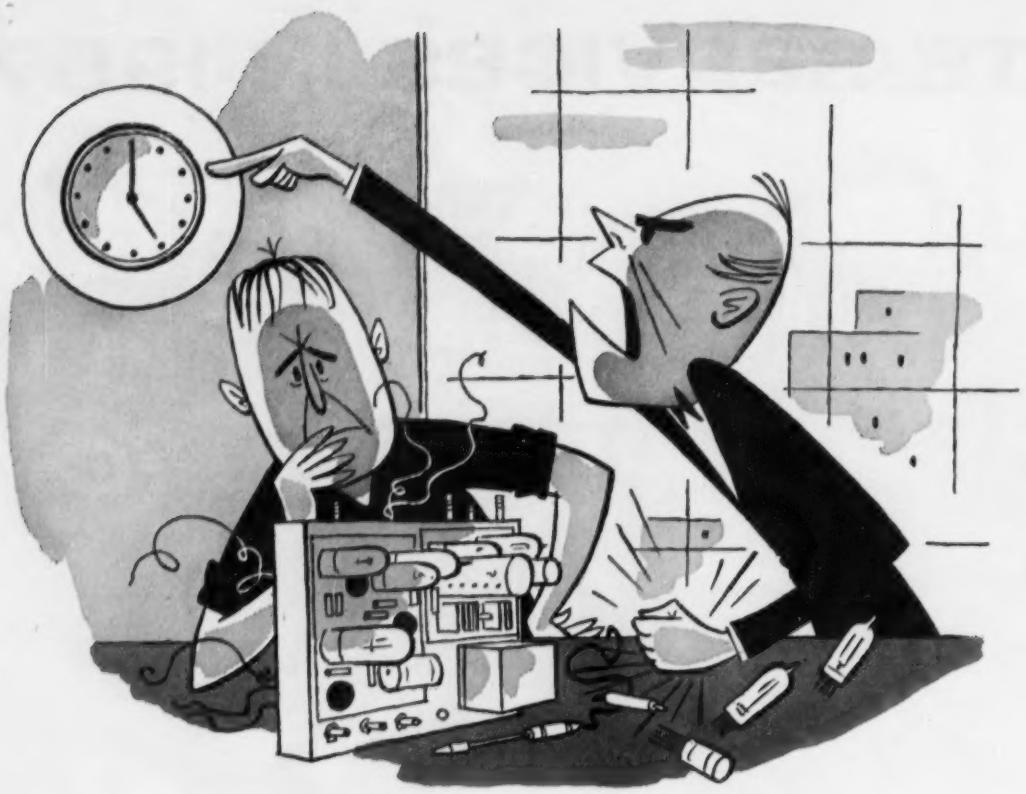

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THE SHORTAGE OF SCIENTISTS AND ENGINEERS:

What Can Be Done About It?

There is no easy or quick way to overcome the shortage of scientists and engineers that has become a threat to our national security and economic progress. The solution can come only through diligent efforts extending over several years to bring the supply of technically trained people into balance with our needs. Meanwhile, the pressure of the shortage can be relieved if industry, government and education make better use of the limited number of scientists and engineers now available.

Earlier editorials in this series have discussed the dimensions of the shortage of technical manpower, its meaning for our national security and our economic well-being and the causes of the shortage. This final editorial will survey some of the measures that can be taken to overcome the shortage. Most of the proposals presented here have been suggested elsewhere. But in combination they appear to offer the best hope of an answer to this serious national problem.

Soviet Methods Not For U. S.

It is clear that no crash program, inspired by panic and designed indiscriminately to drive hordes of high school students into science and engineering, is suitable for the United States. Even if we adopted Soviet methods of channeling a large portion of our brightest young people into technical fields, it would be at least four years before results appeared in the volume of college graduates. And such an approach would do no credit to the American way of life.

Any crash program, whether it involved totalitarian methods or simply overselling the advantages of technical careers, would be objectionable for other reasons as well. It would jeopardize the quality of scientific and engineering training. It would put many young people in fields where they have little aptitude and deny them to other fields for which they are better equipped. And, if carried too far, it might even result in the overcrowding that was feared prematurely a few years ago.

The most important problems for the long run, as the preceding editorial in this series indicated, are in the area of education. Any real solution must reduce the loss of talented high school graduates who do not continue their education for financial reasons or because of lack of interest. Also, it must improve the quality of high school preparation in science and mathematics and, above all, relieve the critical shortage of teachers.

Basic Needs in Education

Substantial increases in salaries of teachers in most of the nation's school systems are essential if high school students are to receive adequate preparation for courses in science and engineering. Pay scales that have lagged behind rising living costs and salaries available in industry have placed great strain on even the most devoted teachers. There has been a sharp drop in the number of new graduates trained to teach science and mathematics, and of this smaller number many have decided not to follow careers in teaching.

Raising teachers' salaries to more realistic levels must be primarily the job of local school districts, aided by state governments. If, in face of rapid increases in school enrollments, local and state resources prove insufficient, then federal aid will have to be considered. Higher teachers' salaries, however financed, inevitably mean higher taxes. But without appreciable improvement soon, the quality of our entire educational system is in danger.

At the college level also, financial aid is needed to provide scholarships for promising students and to increase faculty salaries. (An earlier series of editorials dealt more fully with these problems, and business aid to higher educational institutions has been mounting at a gratifying rate.)

But not all the educational problems related to the shortage of scientists and engineers can be solved with money. Science and mathematics have steadily been de-emphasized as more youngsters have gone to high school for terminal education rather

How business is helping to relieve the shortage of technical manpower

Summary of a Survey by McGraw-Hill Correspondents

Sponsoring summer study programs for high school teachers

Arranging cooperative work-and-study programs for students

Sponsoring college fellowships and scholarships in science and engineering

Paying tuition of employees taking science and engineering courses

Keeping college faculties abreast of new developments in industry

Hiring high school science teachers for summer and part-time work

Giving old, but usable, laboratory equipment to schools

Cooperating in high school science exhibits

Sponsoring regional science fairs

Sending speakers and training aids to schools

Opening plants for student tours

Analyzing jobs to relieve engineers and scientists of routine work

The McGraw-Hill Department of Economics will be glad to hear of any other ways business is helping relieve the shortage.

than for college preparation. This de-emphasis must be reversed.

Techniques of instruction, furthermore, can stand improvement at all levels of education. Professor E. P. Northrup of the University of Chicago observes: "In the past fifty years . . . there has been a revolutionary change in the character of mathematics, yet not a trace of this change is to be found in the curricula of all but a handful of secondary schools throughout the country." Colleges and universities may have to examine old fetishes about light teaching loads and small classes in order to make more efficient use of their faculties.

What Industry Can Do

Industry has the immediate problem of better utilization of available technical manpower and the long-range responsibility of helping increase our resources of trained people. Frantic recruiting practices and reckless bidding up of starting salaries—financed largely by government money for defense orders — are not the answer. There is need for earnest consideration of incentives for experienced scientists and engineers, who too often must look to sales or executive positions for adequate financial recognition.

Industry in many instances could make more efficient use of engineers and scientists by shifting work to technicians, clerical personnel and even machines. One company found that 15% of the time of an engineering design group was spent on routine jobs and that this valuable time could be saved by adding a technician and a clerical worker to the group.

Other potential sources of technical manpower could be tapped more extensively to relieve the shortage. Very few women have entered what has been traditionally a man's world. Negroes are only slowly gaining educational and employment opportunities in technical fields. And many experienced older men can still give useful service.

A Good Beginning

Much is being accomplished already in efforts to attract more young people into scientific and engineering careers. A summary of some of the things business is doing is presented above. Other notable contributions are being made by such organizations as the professional engineering and scientific societies (especially through their manpower commissions), the National Science Foundation, the National Research Council, the National Education Association, the National Merit Scholarship Foundation and the Thomas Alva Edison Foundation.

Results are beginning to appear in rising enrollments in engineering schools and technical institutes. Between 1951 and last year, according to McGraw-Hill's annual survey of technical institutes, enrollments in these schools rose from 46,000 to a record 67,000. Engineering enrollments rose in the same period from 166,000 to 243,000. A rising tide of graduates is already being made available to American industry.

This is a good beginning. But only with wider appreciation of the serious implications of the shortage of scientists and engineers and intensified efforts on the part of business, government and education to relieve the shortage can we hope to overcome this threat to our national security and economic well-being.

This is one of a series of editorials prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments of particular concern to the business and professional community served by our industrial and technical publications.

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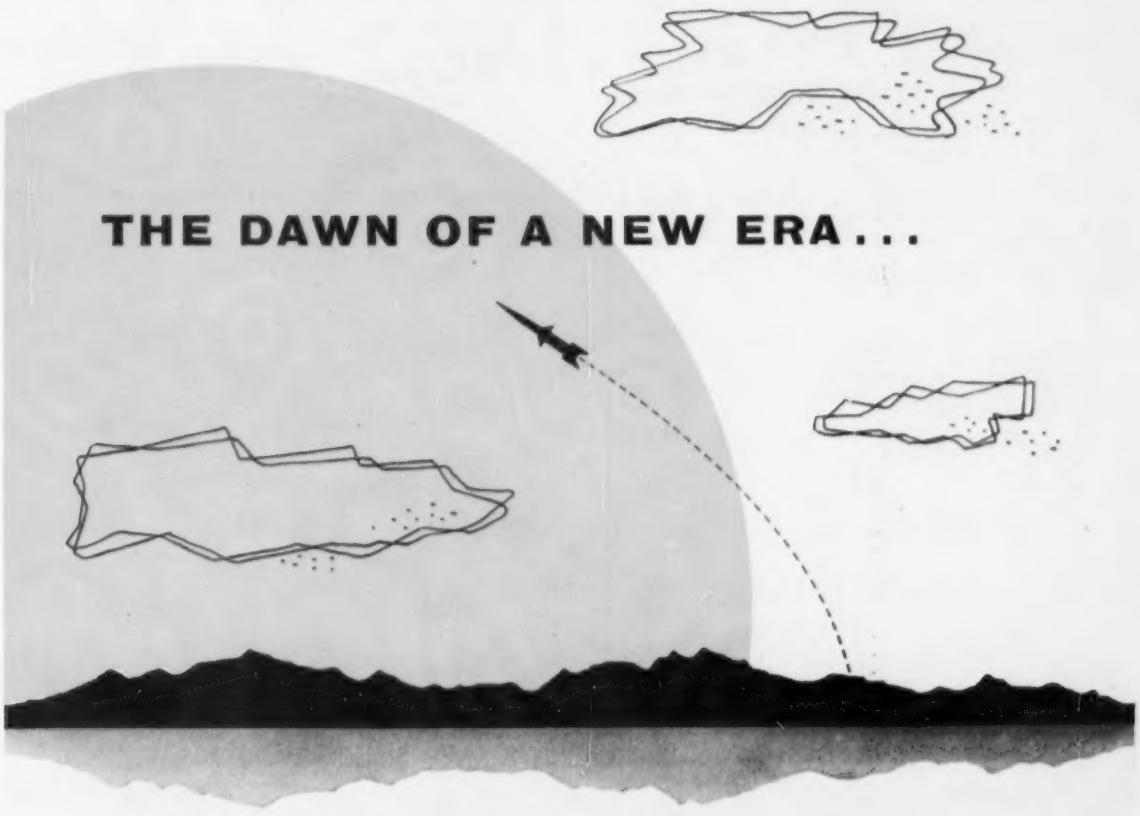

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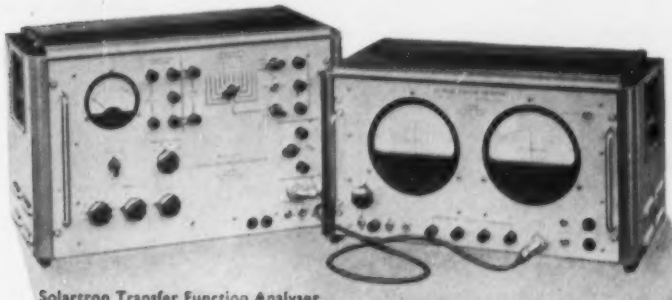

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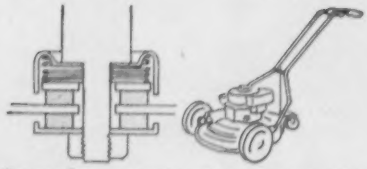
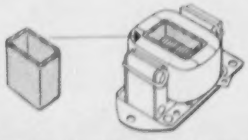
Tips for designers



Rotary lawn mower utilizes abrasion resistance of Taylor phenol laminate washer in slip-clutch attachment of drive shaft to cutting blade.



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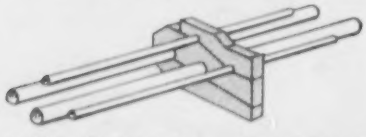

Fuel-line clamp for a fighter plane's "pipeline" system is machined from Taylor fabric base laminate which has high mechanical strength and resists extreme temperature and humidity.

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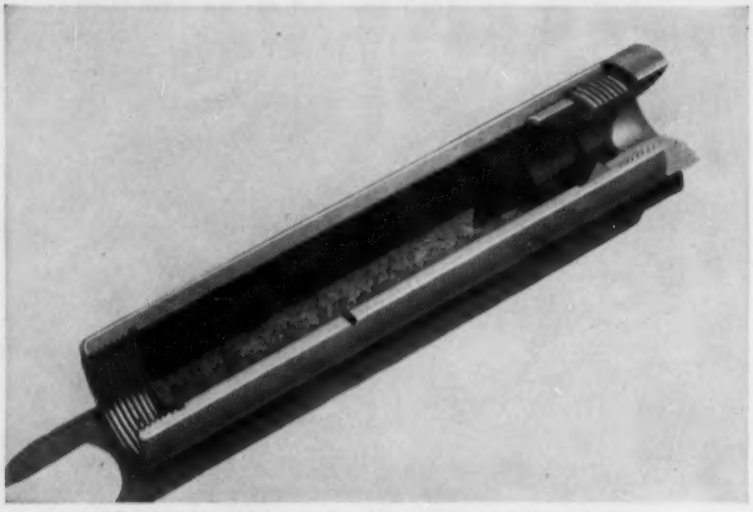

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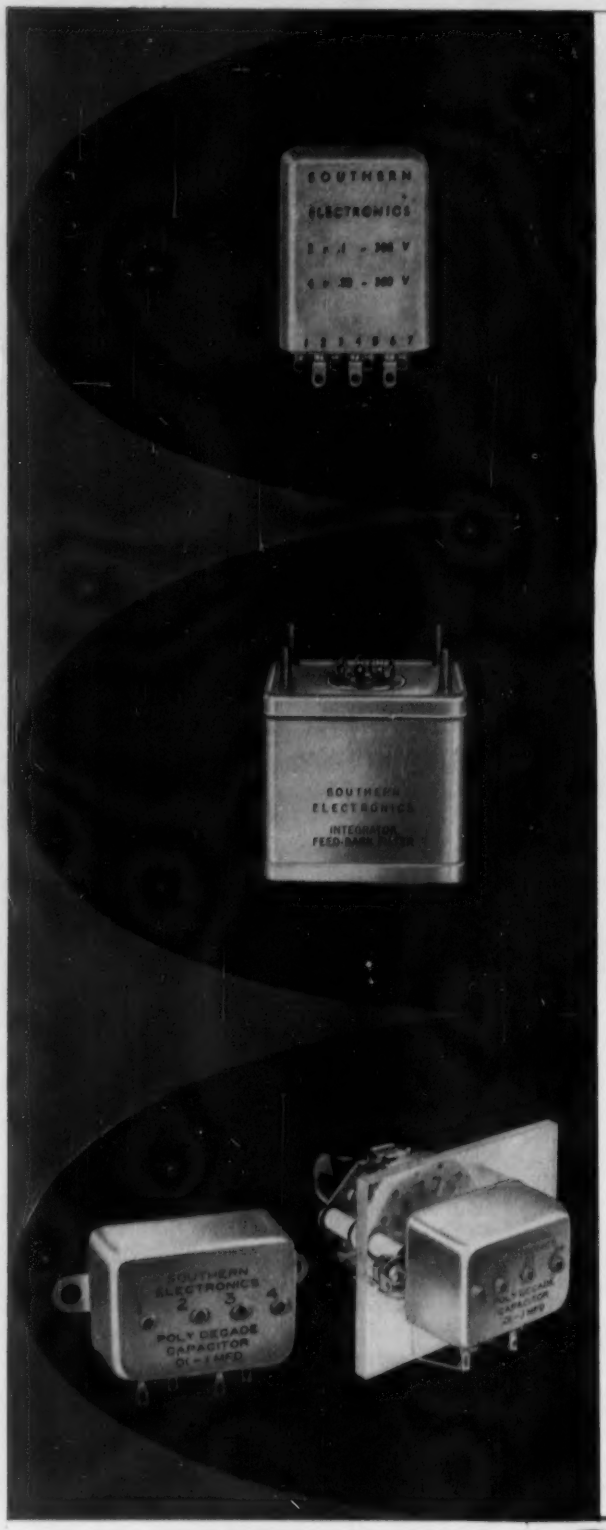

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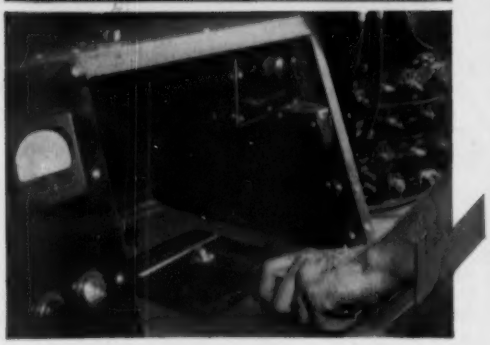

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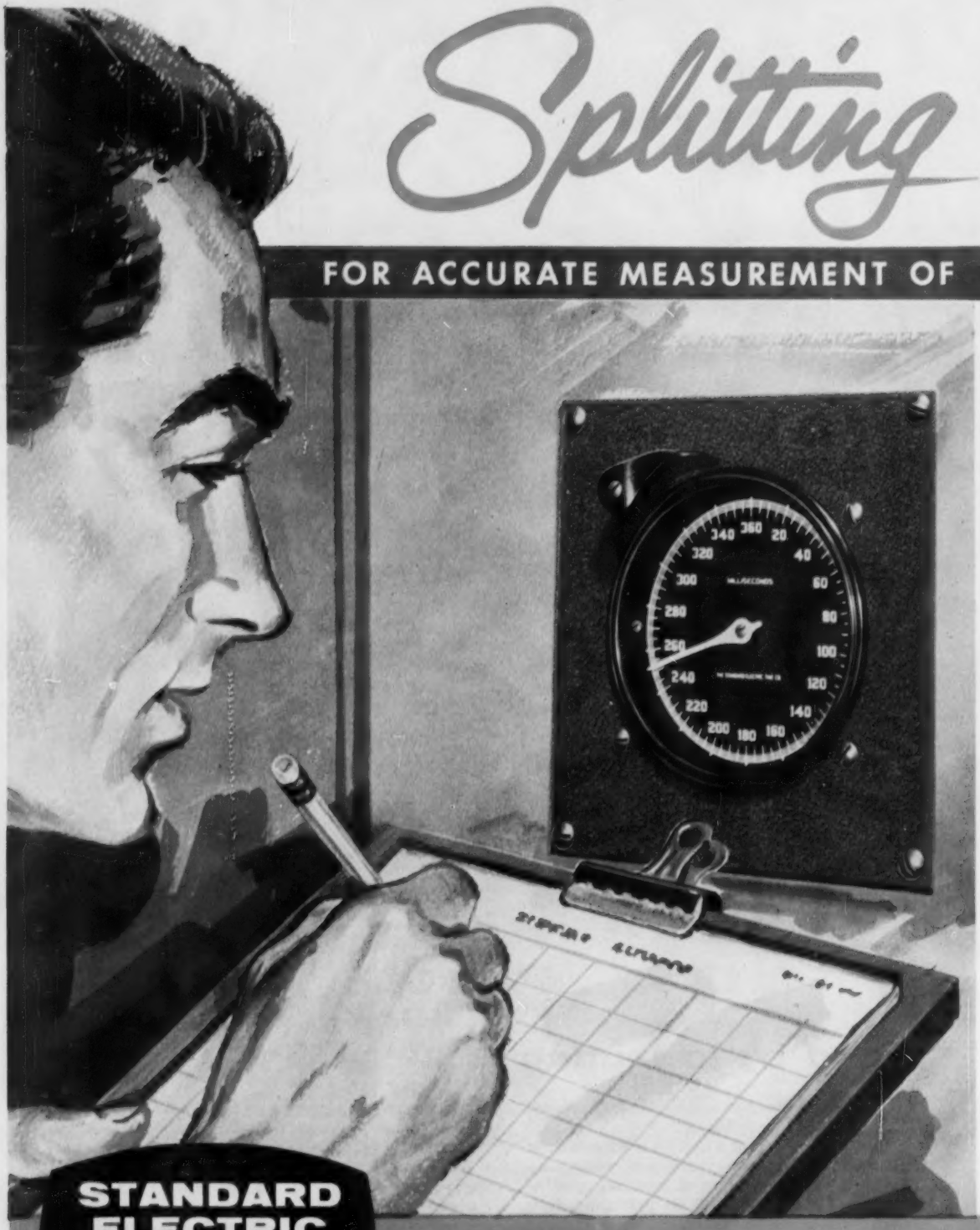

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At one of the world's largest automotive manufacturers — timing test action in automatic transmission research.

It is our frank belief that literally hundreds of concerns have not yet scratched the surface of usefulness to which Standard Precision Timers can be put to work in their plants.

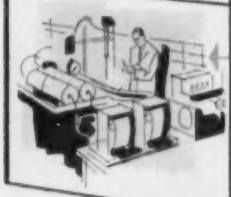
For Glenn L. Martin Co.'s Gunnery Trainer — in 12-channel Playback System designed by Cook Research Laboratories.

At Eastman Kodak Co. — timing photo cell controlled exposures in automatic photo printing machine.

At Yucca Pass, Nevada Proving Grounds — helping maintain split-second control of atomic bomb tests.

At General Electric Co. — Trumbull Division — measuring operating time of circuit breakers.

In Bell Telephone offices throughout the U. S. — timing elements required to complete telephone connections.



At Bendix — Westinghouse Research Dept. laboratories — measuring brake application and release time to 1/100th of a second.

At American Brass Co. — indicating metallurgical analysis in Direct Reading Spectroscope developed by Baird Associates.

Model	Scale Divisions	Totalizes	Accuracy
S-100	1/5 sec.	6000 sec.	±.1 sec.
S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min.
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	360 sec.	±.001 sec.
MST-500	1/1000 sec.	30 sec.	±.002 sec.

World's most accurate and rugged time measuring instrument. Built in many different and advanced designs to meet practically every need of precision time measurement. Requires minimum maintenance.

Synchronous motor drive. Electric clutch controlled by manual switch, automatic switch or output of electronic tubes. Manual or electric zero reset.

SEND TODAY for Bulletin #198 describing entire line with partial list of thousands of customers, and summary of some of the most frequent (and some of the most unusual) ways they use STANDARD ELECTRIC TIMERS.

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Please send Bulletin 198 describing your line of instruments for measuring elapsed time as close as 0.001 seconds.

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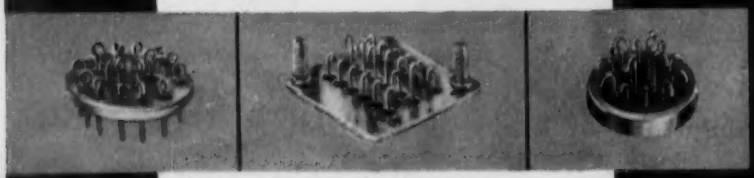
glass-to-metal seal quality

Tomorrow's aircraft must be built to withstand great extremes of temperature, pressure and vibration — every component must perform its functions accurately and dependably at speeds of 2,000 miles per hour or more.

Constantin vacuum-tight, glass-to-metal seals were developed to meet the great extremes of operating conditions that lie ahead. Never-ending research and development are carried on by Constantin's resourceful design engineering staff to insure maximum performance and non-leakage. This quality control and development make Constantin units *ideal* for use with complex systems or miniaturized components.

This long experience in the design and manufacture of thousands of types of glass-to-metal seals will solve the most difficult vacuum-sealing problems.

Write today to find out how this experience and design versatility will help you.



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Where the connection is remote...

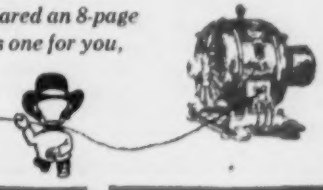
new Deutsch miniature push-pull electrical connectors

With three strong men, a sackful of special tools, a small boy on the end of a fishing line, and a bucket of patience . . . you can make remote electrical connections with conventional connectors. In hours.

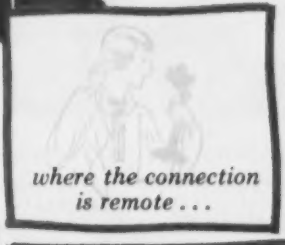
Or, you can use a new Deutsch Miniature Push-Pull Electrical Connector. Simply push it in with a tube for automatic lock and seal . . . pull back on a lanyard for instant disconnect. In seconds.

Which would you choose?

Interest in our complete line of electrical connectors has reached such a fever pitch we've prepared an 8-page 2-color brochure describing them. There's one for you, too. Just send for Bulletin 1101.



Where the connection is blind . . .

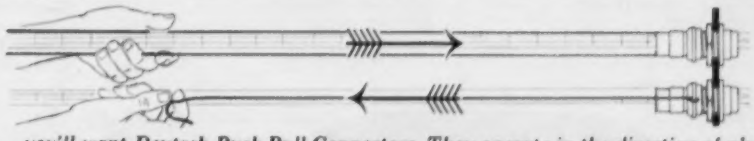


where the connection is remote . . .

where the installation is crowded . . .

where the problem is size . . .

where the disconnect is ballistic . . .



. . . you'll want Deutsch Push-Pull Connectors. They operate in the direction of plug travel, without threading, bayonet or coupling nut. Push-pull. That's all. (And they meet AN "E" requirements, too.)

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planning on **LONG LIFE?**

El-Menco DUR-MICA Capacitors *will match your equipment's life expectancy to at least 15 years!*

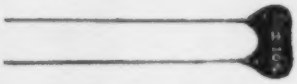
A recent series of the toughest trials has proved El-Menco DM15, DM20 and DM30 Dur-Mica Capacitors outlast all others. Accelerated conditions of 1½ times rated voltage at ambient temperature of 125° centigrade found El-Menco capacitors still going strong after 10,000 hours. Similar conditions obtaining under normal usage would equal a lifetime of over 15 years!

Tougher phenolic casing means *longer life, greater stability,* over wide temperature range.

Meet all humidity, temperature, and electrical requirements of both civilian and MIL-C-5 specs.

Parallel leads simplify use in television, electronic brains, miniature printed circuits, computers, guided missiles, and other civilian and military applications.

DM15



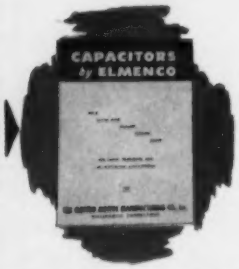
Actual Size

DM20

El-Menco Dur-Mica DM15, DM20, and DM30 Capacitors Assure:

1. LONGER LIFE
2. POTENT POWER
3. SMALLER SIZE
4. EXCELLENT STABILITY-SILVERED MICA
5. PEAK PERFORMANCE

Tell us your specific needs. Write for FREE samples and catalog on your firm's letterhead.



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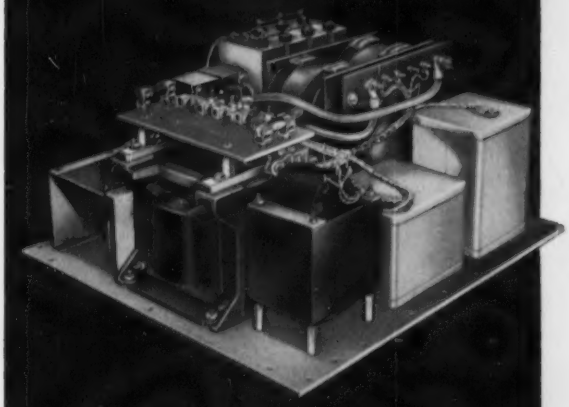
to replace . . .

NO TRANSISTORS

NO MOVING PARTS
to wear out

STABILINES type TM (Tubeless Magnetic) are the newest automatic voltage regulators offered by The Superior Electric Company. Without tubes, moving parts or transistors, the TM's provide constant voltage regardless of line or load changes. Where failure at any time under the most adverse operating conditions cannot be tolerated or where maintenance is not a possibility for long periods of time, a STABILINE type TM is a necessity.

STABILINE* TYPE TM
(Tubeless Magnetic)



TYPE TM7105 (without cabinet)

TYPE TM7105 (with cabinet as mounted on wall)

FOR UNATTENDED LOCATIONS

- Microwave relay stations
- Remote installations

FOR CRITICAL APPLICATIONS

- Where sudden need for tube replacement can be costly (at a critical time in a process) or impossible (at an unattended location)
- Where conditions cannot tolerate moving parts.

Be sure to see SUPERIOR ELECTRIC'S Mobile Display when it is in your area.

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STABILINE TYPE TM CHARACTERISTICS

INPUT: 95-135 volts, single phase on nominal 115 volt types
195-255 volts, single phase on nominal 230 volt types

OUTPUT: Adjustable 110-120 volts on nominal 115 volt types
Adjustable 220-240 volts on nominal 230 volt types

ACCURACY: 1 volt band for line voltage variations and/or load magnitude and power factor changes

FREQUENCY: 60 cycles ±5%

WAVEFORM DISTORTION: 4% maximum

RESPONSE TIME: Less than ½ second for ordinary line and/or load changes. For extreme conditions of line and load changes, maximum response time is 2.0 seconds. (Response time is measured from the time of initiation of transient to the time when output voltage is within and remains within rated limits)

LOAD: Available in 1.0, 3.0 and 5.0 KVA ratings

POWER FACTOR: 0.5 lagging to 1.0

THE SUPERIOR ELECTRIC COMPANY
211 MIDDLE STREET, BRISTOL, CONNECTICUT

Please send STABILINE Bulletin S157 ☐
Have your representative call ☐

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City ..... *Zone* .... *State* .....

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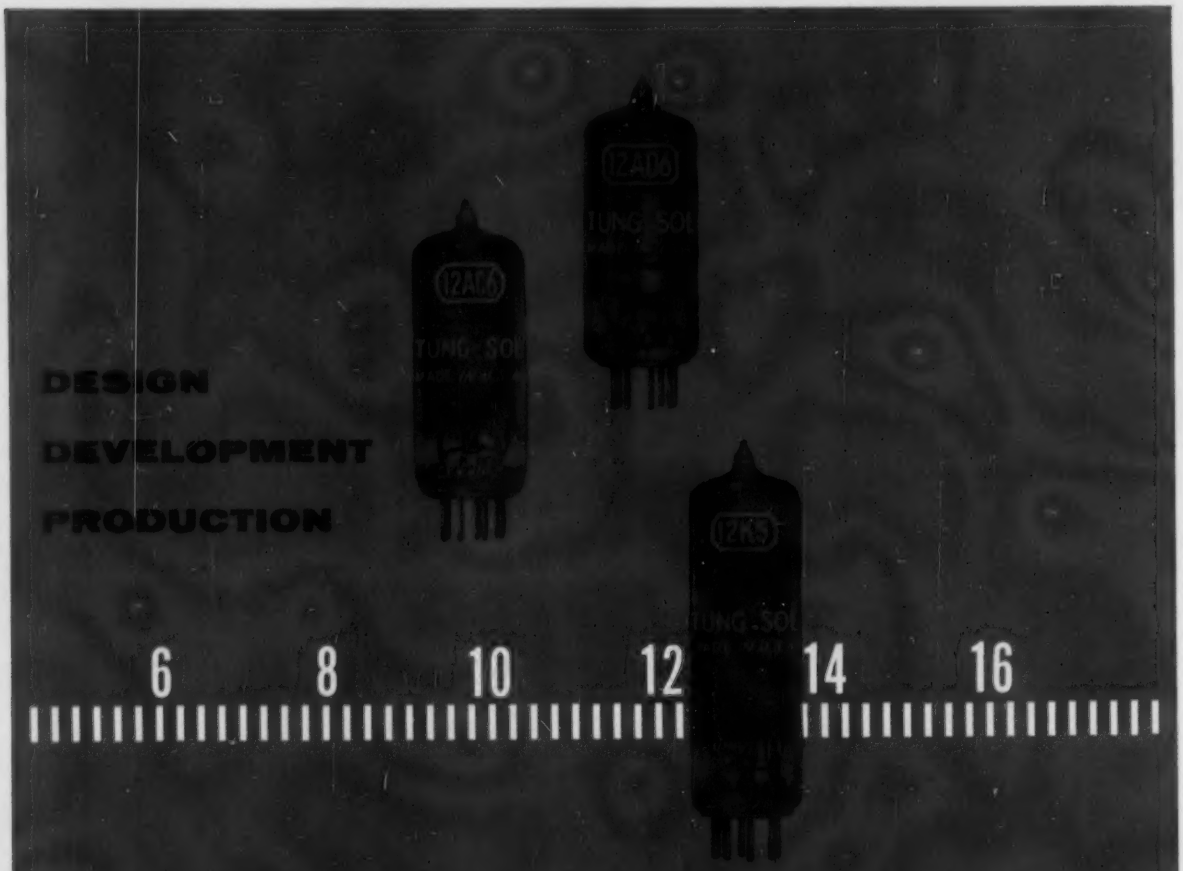

DESIGN

DEVELOPMENT

PRODUCTION

These four tubes, newly engineered by Tung-Sol, are the 12-volt tube complement for the first successful hybrid car radio.

It is the Tung-Sol policy to offer engineering assistance impartially and to treat all information received in strictest confidence. Tung-Sol does not manufacture radios or television sets.

TUNG-SOL®

ELECTRON TUBES

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TUNG-SOL ELECTRIC INC., NEWARK 4, N. J. *Sales Offices* Atlanta, Ga., Columbus, Ohio, Culver City, Calif., Dallas, Tex., Denver, Colo., Detroit, Mich., Irvington, N. J., Melrose Park, Ill., Newark, N. J., Seattle, Wash.

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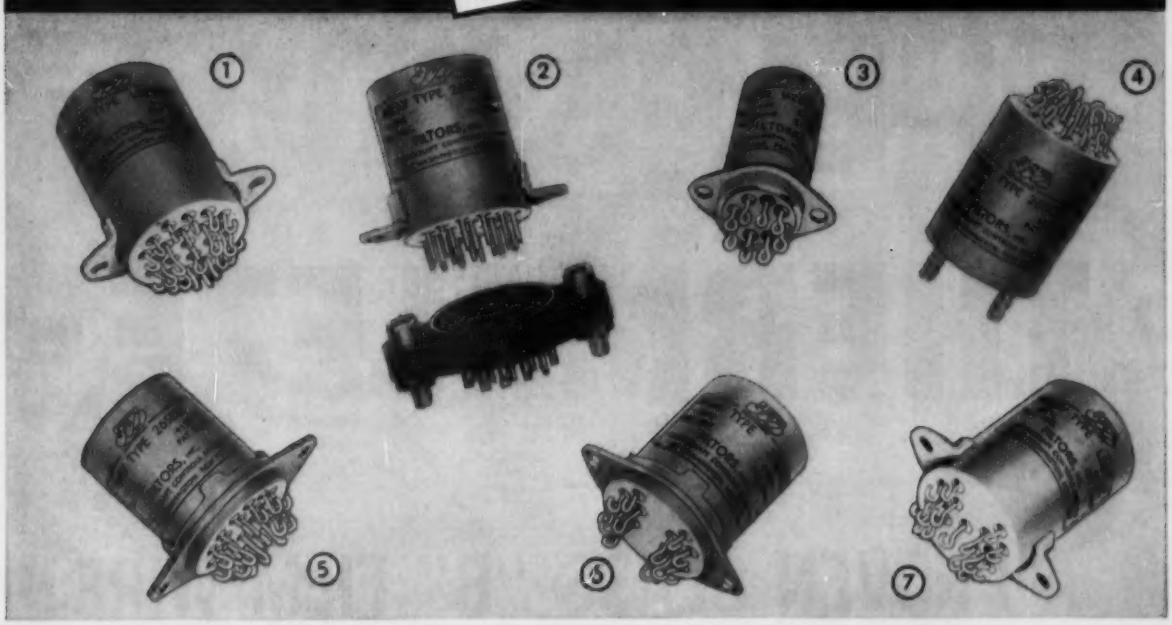
FILTORS SUB-MINIATURE RELAYS



Modern Fireproof Plant

Assembly Wing

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OUR MODERN PRODUCTION FACILITIES AND PRECISION TEST EQUIPMENT *mean QUANTITY + RELIABILITY*

More than 1000 relays a day are being shipped to the largest manufacturers of military equipment in the United States. Constant testing of sample lots from production runs (100% testing in the case of low level relays) has given Filtors relays a reliability rating second to none.

Below is a brief description of the relays pictured above. For complete information regarding these types and other types manufactured by Filtors write for catalog today.

	❶	❷	❸	❹	❺	❻	❼
CONTACT ARRANGEMENT	6PDT	6PDT	2PDT	6PDT	6PDT	4PDT	4PDT
CONTACT RATING (AMPS. RES. at 26.5 VDC or 115 VAC)	3	3	2	3	3	3	3
NOMINAL COIL VOLTAGE (VOLTS D.C.)	26.5	26.5	26.5	26.5	26.5	26.5	26.5
HOUSING DIAMETER	1"	1"	.635"	1"	1"	1"	1"
MOUNTING CENTERS	1.406	1.406	.875	.625	1.562	1.406	1.406
SHOCK (11 millisec)	50G	50G	50G	50G	50G	50G	50G
VIBRATION at 10G	5 to 500	5 to 500	5 to 2000	5 to 500	5 to 500	5 to 500	5 to 500
MAX. OPERATE AND RELEASE TIME AT NOMINAL VOLTAGE (in milliseconds)	10	10	10	10	10	10	10
RELAY TYPE	L26F18	26SP18	M26FC6	26SC18	26SE18	26SR12	L26F12

FOR DRY CIRCUIT (LOW LEVEL) RELAYS ADD THE LETTER "S" AT THE END OF THE TYPE DESIGNATION. EXAMPLE: TYPE 26SP18S

All made to MIL-R-5757 and MIL-R-25018 (USAF)

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A PROVEN CLASS "B" FILM WIRE!

- Dielectric twist performance establishes Thermaleze as Class "B".
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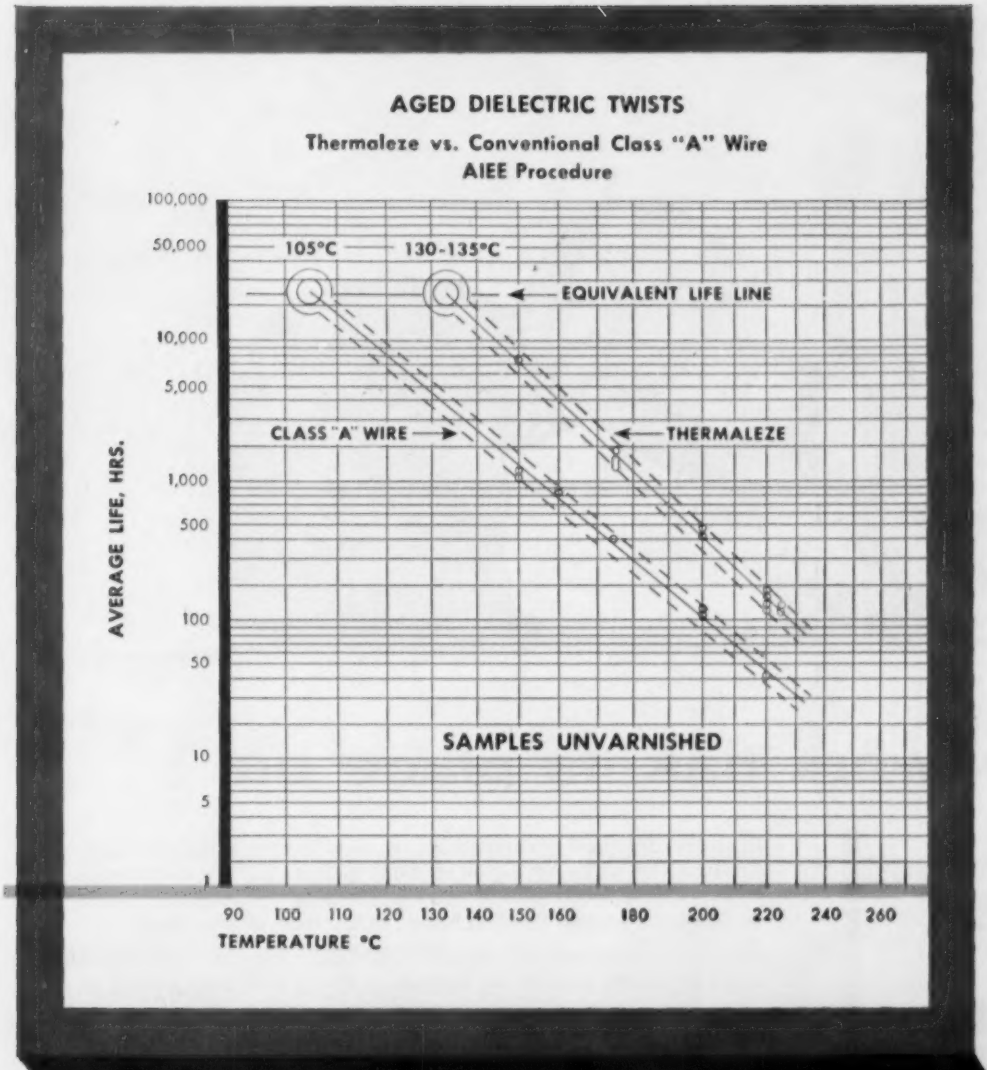
- Over seven years' practical experience in coils, motors, and transformers.
- Essential balance of mechanical, chemical and electrical properties.

Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer!

FIRST FOR LASTING QUALITY—FROM MINE TO MARKET !



NEMA twist samples aged in oven at various temperatures following AIEE aging procedures

PHELPS DODGE COPPER PRODUCTS CORPORATION

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Patchwork has its place but . . .

The FIRST 6

In an era of stepped up competition, no manufacturer can hope to keep pace with the field while relying on obsolete "patchwork" instrumentation. . . . Almost hourly, electronics research is spawning new instruments designed to perform a specific function better, in less time, at lower cost.

But here's where your independent FIRST SIX* manufacturers' representative enters the picture. He represents what's new, what's right in electronic product design. What's more he's technically qualified to recommend and apply industry's newest product innovations advantageously to your instrumentation problems.

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*** THE FIRST SIX — Six leading, independent manufacturers' representatives functioning cooperatively for the advancement of improved electronic instrumentation in industry.**

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SONIC INDUSTRIES' PHONOGRAPHS AND COMBINATIONS USE GENERAL ELECTRIC "THRU-CON" PLATED PRINT WIRE BOARDS

The chassis requirements of Sonic Industries' famous "Capri" models could not be met with conventional etched type circuits or wiring. Sonic engineers utilized the space-saving, two-sided characteristic of General Electric exclusive "Thru-Con" process to design their compact chassis.

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Model 6505A is a direct reading precision device for measuring AC frequencies near 400 CPS.

The VARO Model 6505A Frequency Meter is designed for use in laboratories and test areas. It is rack-mounted. Three precision tuning fork oscillators are used to calibrate the Frequency Meter and to maintain its accuracy and linearity. They maintain a reference frequency accuracy of better than 0.02%.

A recorder output is included for driving a suitable recording device. The output voltage is directly proportional to the frequency of the measured voltage and exceptionally linear.

The Model 6505A is insensitive to transient voltage changes and harmonic or waveform distortion. It requires no adjustment for operation with any signal input voltage from 6 to 250 volts.

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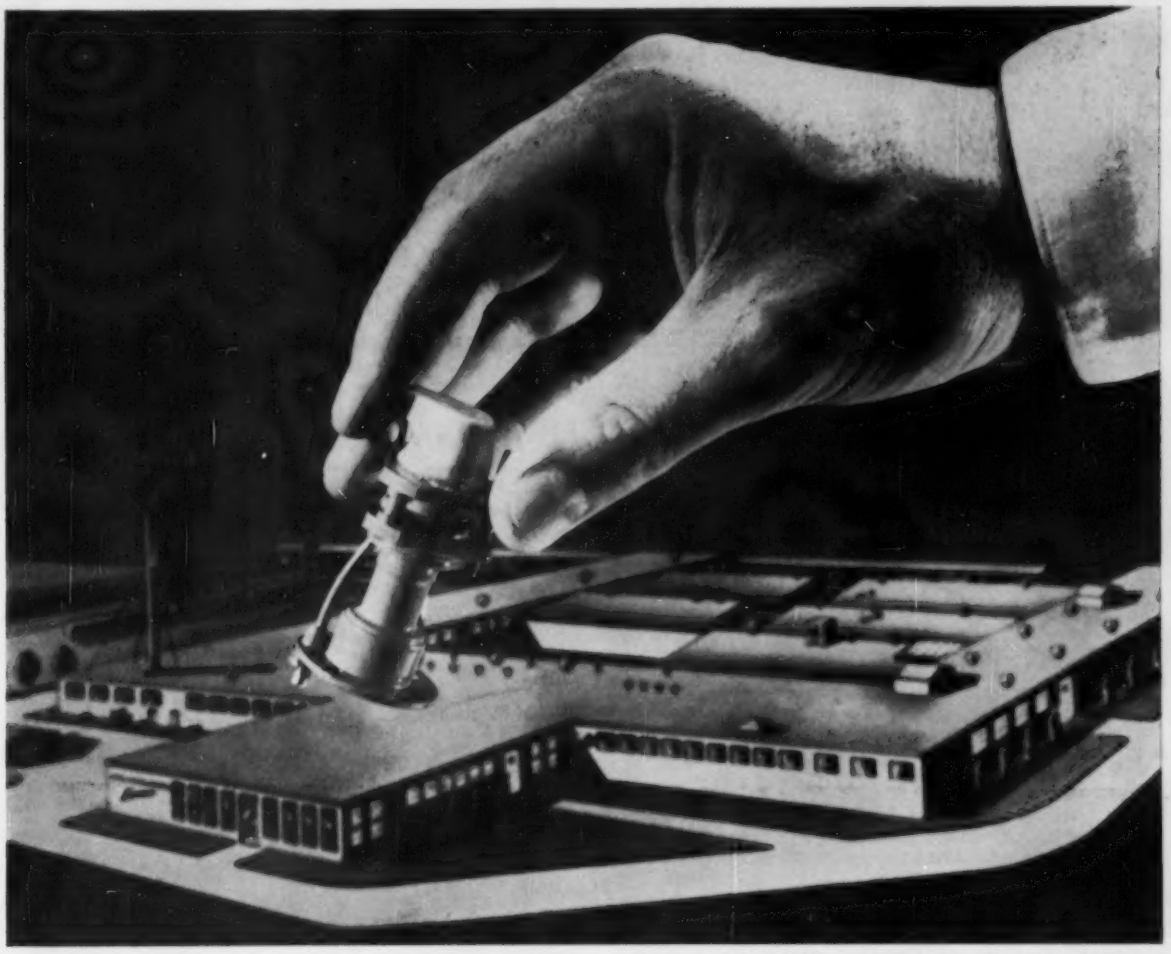

Hand holds Eimac 1K015CA local oscillator C Band Klystron, 5400-6000 mc

New EIMAC Microwave Center Open at Salt Lake City for Research and Production of Local Oscillator Klystrons

A new microwave facility for Eimac local oscillator reflex klystron research and production has opened at our Salt Lake City, Utah plant. For 13 years of the 22-year history of Eitel-McCullough, Inc., the production excellence of the Salt Lake City installation has been instrumental in establishing Eimac as the world's largest manufacturer of transmitting tubes.

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EL34

Britain's foremost pentode for 25W high fidelity equipment

The Mullard EL34 can be rightly acclaimed as the most efficient high fidelity output pentode tube yet produced in Britain. It is being fitted in many of the British sound reproducing equipments which are becoming increasingly popular in the United States and Canada.

Used in push-pull ultra-linear operation (distributed load), two EL34 tubes will give 32 watts output at a total distortion of less than 1%. The application of negative feedback reduces distortion even further.

The EL34 is equally capable of supplying higher power outputs where an increased distortion level is acceptable. Under class B conditions, 100 watts are obtainable from a pair of EL34 tubes in push-pull for a total distortion of 5%.

Another significant feature of this tube is its high transconductance value of 11,000 μmhos, resulting in high power sensitivity and low drive requirements.

Supplies of the EL34 are now available for replacement purposes from the companies mentioned below.

Principal Ratings

Heater
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Max. plate voltage
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25W

Max. screen voltage
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Max. screen dissipation
8W

Max. cathode current
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Test any Leach relay against any comparable relay on the market. You'll learn in your own laboratory why the aircraft, missile and avionic industries have learned to look for the Leach label when they're looking for:

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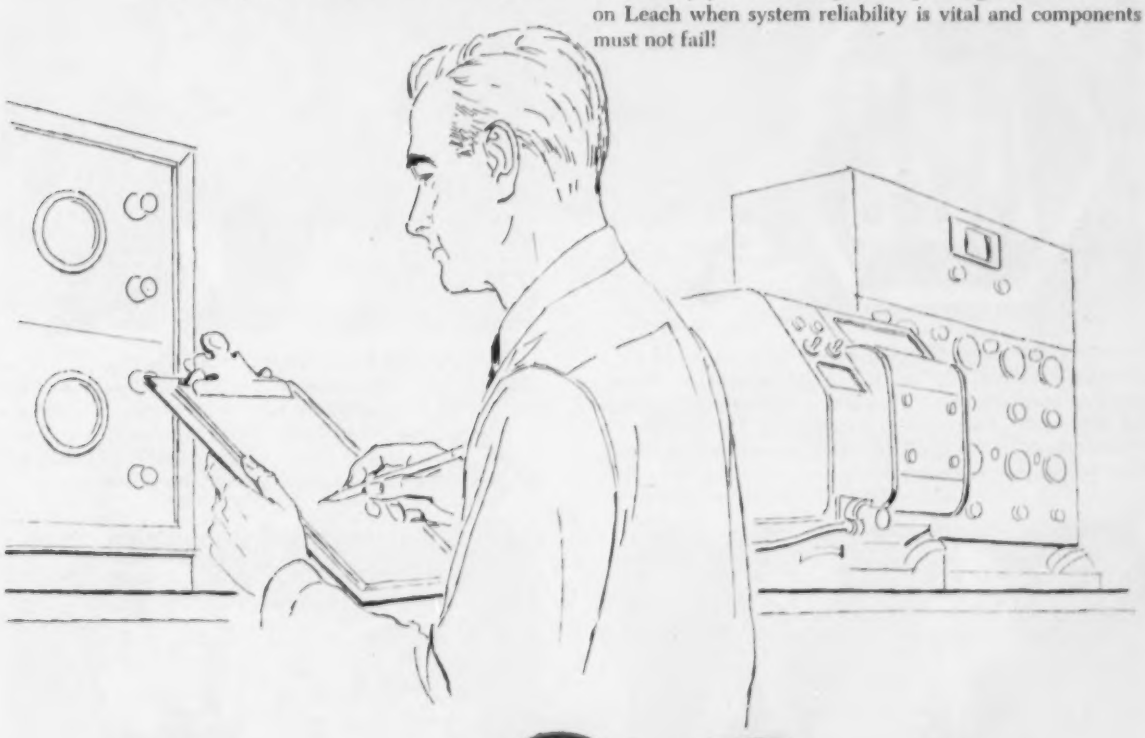

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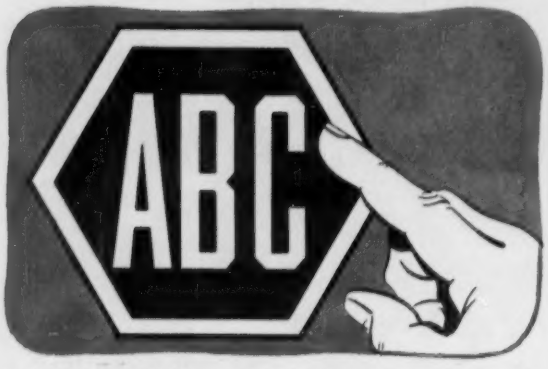

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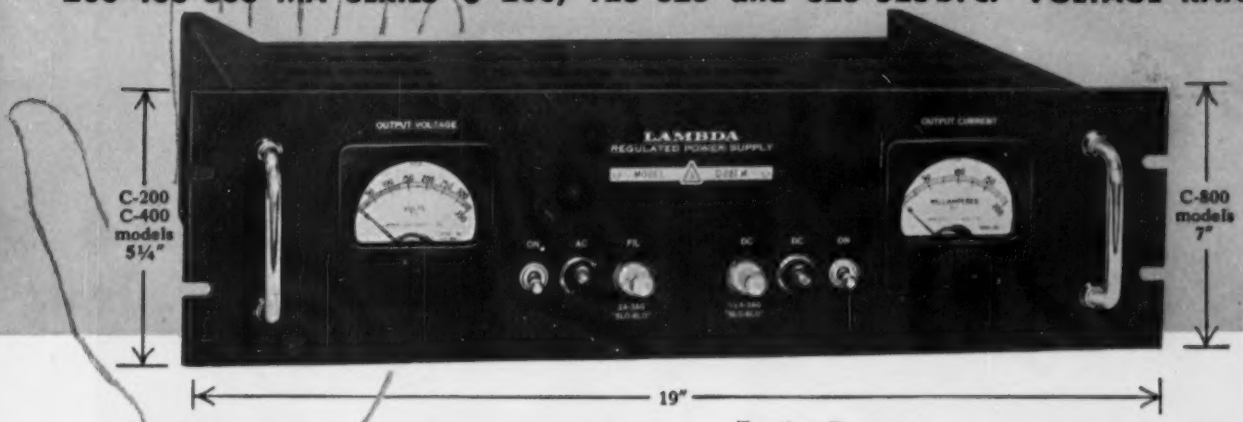
200-400-800 MA SERIES 0-200, 125-325 and 325-525 D.C. VOLTAGE RANGES



COM-PAK MODELS RANGES AND PRICES

Model[1]	Output Voltage[2]	Output Current[3]	Base Price[1]
C-280	0-200 VDC	0-200 MA	184.50
C-281	125-325 VDC	0-200 MA	159.50
C-282	325-525 VDC	0-200 MA	169.50
C-480	0-200 VDC	0-400 MA	259.50
C-481	125-325 VDC	0-400 MA	244.50
C-482	325-525 VDC	0-400 MA	259.50
C-880	0-200 VDC	0-800 MA	340.00
C-881	125-325 VDC	0-800 MA	315.00
C-882	325-525 VDC	0-800 MA	360.00

[1]*For metered models add suffix "M" to model and add $30 to base price. (For example C-281M, $189.50.)*

DC OUTPUT (regulated for line and load):

Voltage ..... Refer to chart above.

[2]*Voltage range for any given model is completely covered in four continuously variable bands.*

Current ..... Refer to chart above.

[3]*Current rating applies over entire voltage range.*

Regulation (line) ..... Better than 0.15% or 0.3 Volt (whichever is greater). For input variations from 105-125 VAC.

Regulation (load) ..... Better than 0.25% or 0.5 Volt (whichever is greater). For load variations from 0 to full load.

Transient Response (line) ..... Output voltage is constant within regulation specifications for step-function line voltage change of plus (+) 10 volts or minus (−) 10 volts rms within the limits of 105-125 VAC.

Transient Response (load) ..... Output voltage is constant within regulation specifications for step-function load change from 0 to full load or full load to 0.

Internal Impedance .....
C-200 Series ..... Less than 6 ohms.
C-400 Series ..... Less than 3 ohms.
C-800 Series ..... Less than 1.5 ohms.

Ripple and Noise ..... Less than 3 millivolts rms.

Polarity ..... Either positive or negative may be grounded.

AMBIENT TEMPERATURE AND DUTY CYCLE ..... Continuous duty at full load up to 50°C (122°F) ambient.

AC OUTPUT (unregulated) ..... 6.5 VAC (at 115 VAC Input).[4]
C-200 Series ..... 10 AMP.
C-400 Series ..... 15 AMP.
C-800 Series ..... 20 AMP.

[4]*Allows for voltage drop in connecting leads. Isolated and ungrounded.*

AC INPUT ..... 105-125 VAC, 50-400 CPS

OVERLOAD PROTECTION:
External Overload Protection ..... AC and DC fuses, front panel, with built-in blown-fuse indicators.
Internal Failure Protection ..... Fuse, rear of chassis.

CONTROLS:
DC Output Controls ..... Band-switches and screw-driver adjusting vernier-control, rear of chassis.
AC and DC Switches ..... Front panel.

Prices and specifications effective November 1956, subject to change without notice.

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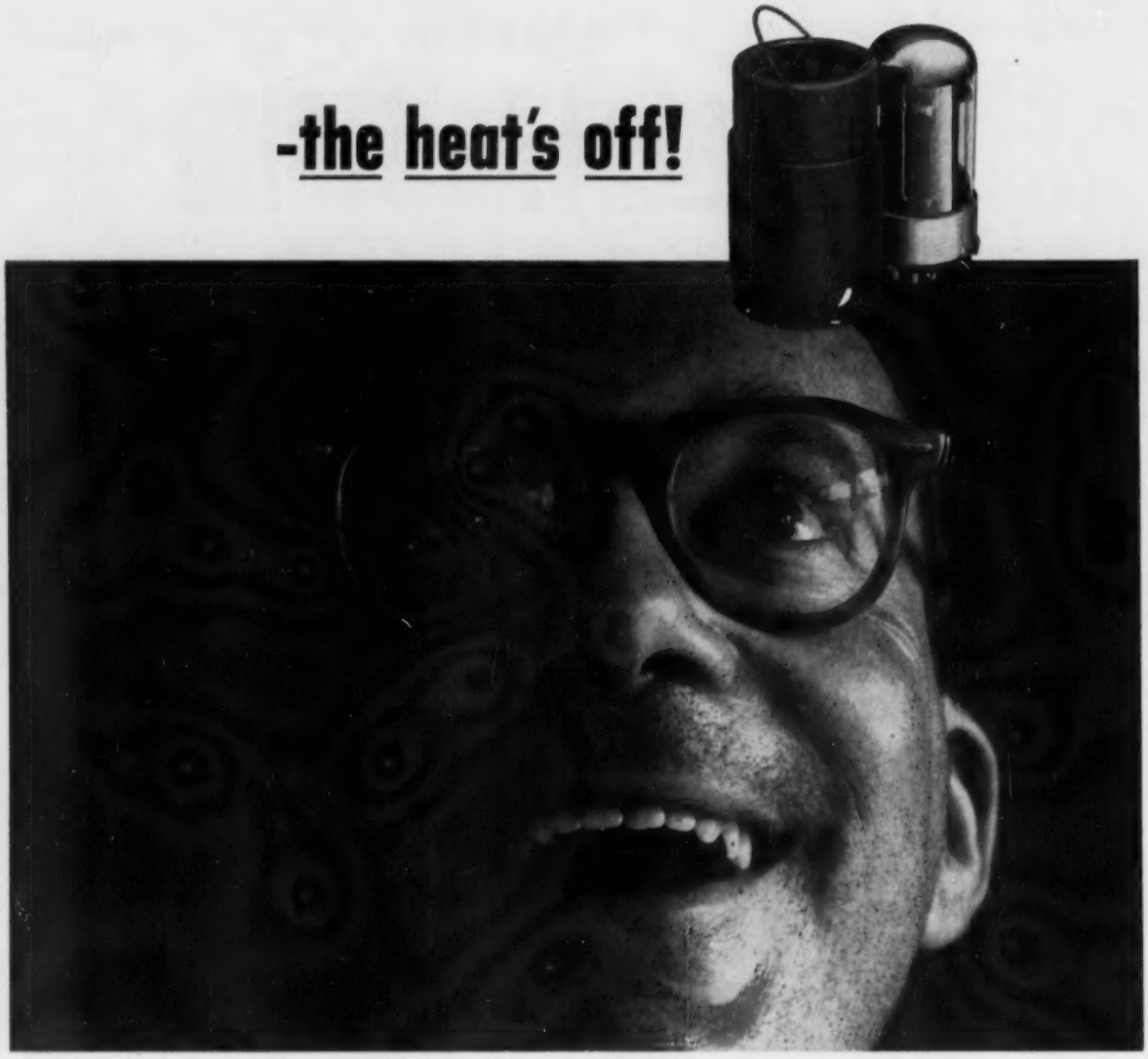

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With IERC Heat-dissipating Tube Shields, the "heat was off" *both* the suffering tubes and our man with the problem! Tube operating temperatures were lowered as much as 150°C and tubes are lasting 5 times longer. Schedules were met – time and money saved – highest tube reliability achieved!

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These five oscilloscopes, although improved in appearance and accessibility, are unchanged electrically. The basic oscilloscope specifications are such that one of the general-purpose plug-in vertical preamplifiers adapts the instruments to practically all ordinary applications. Six additional plug-in units are available for the more specialized applications frequently encountered in many research and development activities.

TYPE 541 OSCILLOSCOPE — dc to 30 mc with Fast-Rise Plug-In Unit. Calibrated sweep range from 0.02 μsec/cm to 5 sec/cm. 10-KV accelerating potential. 0.2-μsec signal delay, 4-cm linear vertical deflection, electronically regulated power supplies, square-wave amplitude calibrator. Price, without plug-in units, **$1145.**

TYPE 545 OSCILLOSCOPE — Same as Type 541 plus triggered and conventional sweep delay, rate pulse generator, and manual or electrical lock-out release for single triggered sweeps. Calibrated sweep-delay range, 1 μsec to 0.1 sec. Price, without plug-in units, **$1430.**

TYPE 531 OSCILLOSCOPE — dc to 11 mc with Fast-Rise Plug-In Unit. 0.25-μsec signal delay, 6-cm linear vertical deflection. Other characteristics same as Type 541. Price, without plug-in units, **$995.**

TYPE 535 OSCILLOSCOPE — Same as Type 531 plus sweep delay and other characteristics of the Type 545. Price, without plug-in units, **$1300.**

TYPE 532 OSCILLOSCOPE — dc to 5 mc vertical response. Calibrated sweep range from 0.2 μsec/cm to 5 sec/cm. 4-KV accelerating potential, 8-cm linear vertical deflection, electronically regulated power supplies, square-wave amplitude calibrator. Price, without plug-in units, **$825.**

PLUG-IN PREAMPLIFIERS

Type 53/54K Fast-Rise Unit	$125
Type 53/54A Wide-Band Unit	85
Type 53/54B Wide-Band High-Gain Unit	125
Type 53/54C Dual-Trace Fast-Rise Unit	275
Type 53/54D High-Gain Differential Unit	145
Type 53/54E Low-Level Differential Unit	165
Type 53/54G Wide-Band Differential Unit	175

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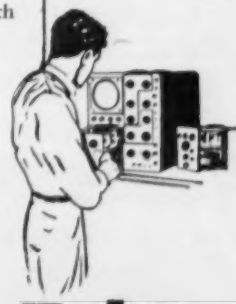

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RCA

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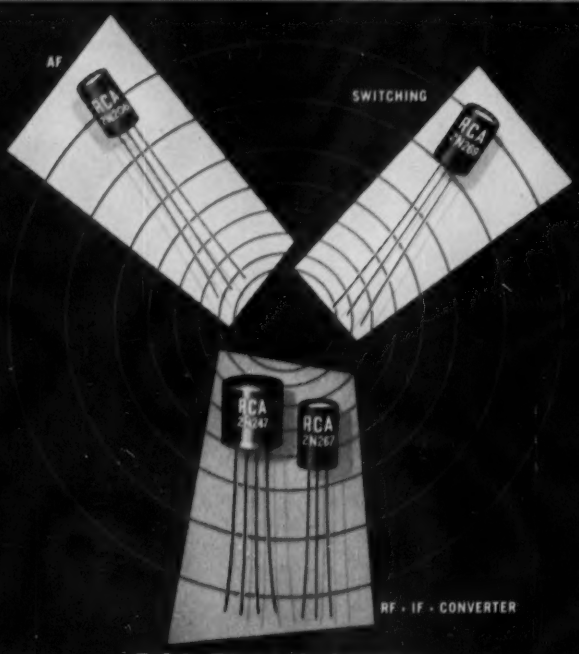


RCA TRANSISTORS

NEW RCA HIGH-QUALITY TRANSISTORS –for HIGH-FREQUENCY...COMPUTER...MILITARY APPLICATIONS

TRANSISTOR MEETS MIL-T-25380/4 (USAF) SPECS . . . RCA-2N206. Manufactured under rigid controls to insure extreme stability and uniformity of characteristics both initially and throughout life, this transistor undergoes temperature cycling and moisture-resistance tests, to give reliable performance **even under severe environmental conditions!** RCA-2N206 is a hermetically sealed, germanium p-n-p type intended for use in military and commercial audio-frequency applications. In a common-emitter type circuit with base input, the 2N206 has current transfer ratio of 47, low-frequency power gain of 46 db, noise factor of 9 db, and max. collector dissipation of 75 mw.

"DRIFT" TRANSISTOR OFFERS NEW CONCEPT IN TRANSISTOR DESIGN FOR HIGH-FREQUENCY APPLICATIONS . . . RCA-2N247 germanium p-n-p type with "built-in" accelerating field is intended for use as an rf amplifier in military, commercial, and entertainment-type equipment operating at frequencies covering the AM broadcast band and up into the short-wave bands. Also useful as intermediate-frequency amplifier or mixer-oscillator (converter). This transistor features low base resistance and very low feedback capacitance (1.7 μμf) which permits the design of rf amplifier circuits having high input-circuit efficiency, excellent operating stability, good automatic-gain-control capabilities over a wide-range of input signal levels, and good signal-to-noise ratio. RCA-2N247 has four flexible leads and utilizes shielding to minimize interlead capacitances and coupling to adjacent circuit components. The RCA-2N267 drift transistor having three flexible leads and intended for compact designs, is also available.

TRANSISTOR FOR COMPUTER AND OTHER "ON-OFF" CONTROL APPLICATIONS . . . RCA-2N268. Having excellent stability and uniformity of characteristics during life, this hermetically sealed germanium p-n-p type transistor is especially suited for use in low-level, medium-speed "on-off" control applications such as flip-flop and gating circuits. Careful control of the characteristics of the junctions with respect to saturation current, leakage current, and breakdown voltage insure dependable performance in switching applications. Max. emitter and collector currents, 100 ma; minimum alpha cut-off frequency, 4 Mc; large-signal current transfer ratio, 35 at a collector-to-emitter voltage of -0.15 volt.

NEW MASTER VOLTOHMYST Features WIDE-VISION METER FACE

RCA-WV-87B . . . designed for high accuracy, this new instrument is well suited to general laboratory use as a portable or rack-mounted vacuum tube voltmeter/ohmmeter and ammeter. The 7½-inch meter face provides large, easy-to-read scales. A mirror-strip on the meter face enables the reader to eliminate needle-to-scale parallax. Tracking error of the meter movement is only ±1% or less. The meter movement is accurate to ±2%. Overall accuracy is ±3% full-scale on all ranges. RCA-WV-87B is supplied complete with WG-299C probe with built-in switch for selecting DC/AC-Ohms. The probe has an exceptionally flexible low-capacitance cable. Frequency response 30 cps to 3 Mc (for source impedance of 100 ohms) on ranges to 500-v. rms, 1400-v. peak-to-peak.

NEW HIGH-SPEED TOROIDAL FERRITE CORE

RCA-221M1 . . . is characterized by a hysterisis loop which permits the core to reverse its magnetic flux polarity when the correct current combination from two associated windings is coincidentally applied. Because of this characteristic, the 221M1 is used in matrices of the coincident-current type as a storage device for digital computers. Diameter is 0.081 inch.

Static Characteristics at Ambient Temperature of 25°C

Magnetizing Force required for optimum squareness	1.8 oersteds
Maximum Flux Density	1730 gausses
Maximum Remanent Flux Density	1620 gausses
Coercive Force	1.2 oersteds
Squareness Ratio	0.86

FOR DESIGNERS

THREE NEW "PENCIL" TUBES FOR UHF EQUIPMENT DESIGNS

These new "A" versions retain the desirable characteristics of their prototypes but, in addition, undergo special tests for fracture, vibrational acceleration, low-frequency vibration, heater-cycling, survival, and one-hour stability life performance. All of these tubes can be operated at altitudes up to 60,000 feet in unpressurized equipment and are particularly suitable for use in mobile equipment and aircraft transmitters.

RCA-5876-A is a general-purpose, high-mu triode for use in cathode-drive circuits as an rf power amplifier and oscillator, if amplifier, or mixer tube at frequencies up to 1000 Mc; to 1500 Mc as a frequency multiplier; and to 1700 Mc as an oscillator. It is capable of giving a useful power output of 5 watts at 500 Mc as an unmodulated class C rf amplifier; 3 watts at 500 Mc and 750 milliwatts at 1700 Mc as an unmodulated class C oscillator.

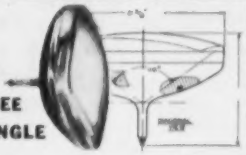
RCA-6263-A is a medium-mu triode with integral plate radiator, and is intended primarily for use as an rf power amplifier and oscillator in cathode-drive applications. At 500 Mc, it is capable of giving a useful power output of 10 watts (ICAS) as an unmodulated class C rf power amplifier, or 7 watts (ICAS) as an unmodulated class C oscillator. The tube may be operated with reduced ratings up to 1700 Mc.

RCA-6264-A is similar to the 6263-A, and is intended for use particularly as a frequency multiplier. It is also useful as an rf power amplifier and oscillator. As a frequency tripler to 510 Mc, RCA-6264-A is capable of 3.4 watts output; at 500 Mc it is capable of 10 watts output as an unmodulated class C rf power amplifier, and 6 watts as an unmodulated class C oscillator.

ANOTHER TUBE TYPE ADDED TO RCA's COMPREHENSIVE "PREMIUM" QUALITY LINE

RCA-5749 . . . is a remote-cutoff pentode of the 7-pin miniature type designed especially for use as an rf or if amplifier in critical military and industrial applications where dependable performance under conditions of shock and vibration is paramount. Characteristics are similar to RCA-6BA6.

RCA OFFERS NEW PICTURE TUBE with 110-DEGREE DEFLECTION ANGLE



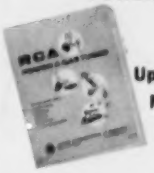
RCA-21CEP4 . . . first commercially available 110° deflection-angle picture tube developed by RCA engineers, establishes new concepts in TV-set styles. Tube depth is approximately 5½" shorter than 90° deflection types. New "straight gun" with "prefocus lens" maintains image sharpness over the entire screen area. The new small neck diameter makes possible the design of a more efficient yoke requiring only slightly more power than is needed for 90° deflection. Tube is aluminized; needs no ion-trap magnet.

Designed for use in 110° deflection-angle systems—for horizontal deflection, RCA-6DQ6-A; for vertical deflection, RCA-6CZ5. Both of these types are now commercially available. In addition, a developmental horizontal deflection transformer and a developmental deflecting yoke—both designed especially for use with 110° tubes—are available on a sampling basis to TV equipment manufacturers.

CERAMIC BUSHINGS—DESIGN FEATURES OF NEW UHF BEAM POWER TUBES

RCA-6816 and -6884 . . . capable of 80 watts cw output at 400 Mc and 40 watts cw at 1200 Mc and **only 1⅞" high, 1¼" in diameter, and 2 ounces in weight**—RCA-6816 and RCA-6884 are exceptionally well suited for oscillator, multiplier, and amplifier use in compact mobile and fixed equipment. Coaxial electrode structure and low-inductance large-area rf electrode terminals **insulated from each other by low-loss ceramic bushings** facilitate the use of these tubes in circuits of the coaxial-cylinder cavity type. Efficient cooling of the plate is effected by a forced-air-cooled integral radiator. RCA-6816 has a 6.3-volt heater. RCA-6884 has a 26.5-volt heater.

"RCA POWER & GAS TUBES" BOOKLET—REVISED Up-To-Date Edition NOW AVAILABLE



PG101C . . . contains descriptions, terminal connections, technical information on RCA vacuum power tubes, rectifier tubes, thyratrons, ignitrons, magnetrons, and vacuum-gauge tubes. The most up-to-date booklet of its kind in the industry. 24 pages. Please use coupon for your copy.

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electronics

W. W. MacDONALD, Editor

NOVEMBER • 1956

CROSS TALK

►**MATURITY** . . . Executives speaking recently before engineer groups on the West Coast several times reaffirmed their faith in bigness. Often protesting that they believed in private enterprise, they still acknowledged the need for spreading costs of research and development over a broad base.

Cited were such examples as government stimulation of transistor research without which they felt we would be ten years behind. Interest in the hydrogen bomb was credited for rapid strides in the study of cryogenics.

In the field of engineer education it was suggested that a national testing standard be established and that college students whose performance measured up be awarded 25-year loans to make possible their training.

Thanks to electronic techniques, the insularity of East, West, and Middle West are rapidly disappearing. It is a healthy realization, and one worthy of engineers, that we live in a big country and must think in big terms.

►**MARS AND BEYOND** . . . It is becoming increasingly difficult to keep man's feet on the ground, literally as well as figuratively.

The British Interplanetary Society has just brought out a magazine devoted to spaceflight. An American publisher is on the stands with one specializing in missiles, rockets and other aspects of astronautics. Newspapers quoting scientists assembled in Rome say the public will be able to hear telemetering signals emanating from America's satellite if they have shortwave radios (which, of course, they will not be able to do unless their sets tune to highly unlikely frequencies up around 220 megacycles). And the Gravity Research Foundation (Roger W. Babson) has held a meeting in New Hampshire, attended not only by many people who have for years been hipped on the subject but also by newcomers with quite tangible industry and government interests.

Us? We're just packing for a mundane business trip to Chicago. By train.

►**RELIABILITY** . . . Differences of opinion relative to the performance of transistors persist, but there is one point upon which most engineers now agree. Certain types already available at least to the military, and others on preproduction pilot lines, are more stable and rugged than some of the resistors, capacitors and other passive circuit elements with which they are being teamed.

Design and production and application techniques have progressed at a rapid rate in recent months.

►**WE WUZ WRONG, ALMOST** . . . Three months ago we passed along a rumor that federal restrictions on credit might soon be relaxed. This could have been important to manufacturers of electronic equipment looking for money, but it did not happen.

What *did* happen was that credit requirements were liberalized on new homes selling under $9,000, which does not directly help our industry meet its immediate commercial needs. It could, however, be a straw in the wind.

The straw is not an especially trustworthy weathervane in this particular month of November.

LOOKING AHEAD . . .

Electroluminescent screens capable of emitting color as function of applied a-c field frequency continue to be actively in minds of television engineers

Superconductors having zero resistance at practical low temperatures may someday eliminate the need for repeaters in long-distance communications cables

Several television equipment makers are working hard to increase picture resolution while at the same time reducing bandwidth requirements; short-range objective is reduction of equipment cost, long-range objective is to be ready for any spectrum regulations the future might bring

Data sending (left) and receiving (right) installations in Philadelphia bank of slow-sweep tv using telephone-company lines

SLOW-SWEEP TV for

By HAROLD E. ENNES

Technical Editor and Systems Engineer
Dage Television Division
Thompson Products, Inc.
Michigan City, Ind.

SUMMARY —— New tv system uses 60-cps horizontal and 2 to 7-cps vertical repetition rates, in conjunction with long-persistence-phosphor display tube, to produce narrow bandwidth video signal of good resolution that can be transmitted over telephone or other audio communication circuits. Reduced scan rates also increase apparent sensitivity of pickup tube

DEVELOPMENT of a slow-sweep tv camera chain utilizing a vidicon pickup tube permits use of a conventional program-type telephone line or remote monitor line to transmit the video output signal.

The system is used to transmit still pictures. A complete picture is scanned every 2 to 7 seconds; the time being adjustable.

The picture tube is a long-persistence-phosphor radar type with a P7 or P19 characteristic, which sets certain limitations on operating concepts. The brightness decay characteristic is such that the picture vertical frequency should be not less than approximately 10 per minute to maintain readable information at the picture top when the bottom scan line has been reached.

For convenience, the horizontal scan rate is synchronized with the a-c line frequency of 50 to 60 cps. Since the number of lines, N, constituting the complete picture is determined by the vertical frequency adjustment, the following relationship exists assuming a 60-cycle horizontal rate:

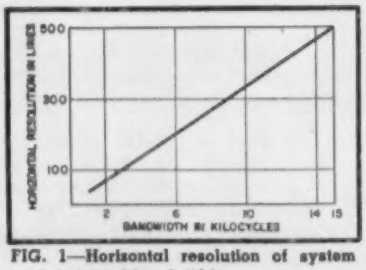


FIG. 1—Horizontal resolution of system as function of bandwidth

3-sec sweep, $N = 60 \times 3 = 180$ lines
4-sec sweep, $N = 60 \times 4 = 240$ lines
5-sec sweep, $N = 60 \times 5 = 300$ lines
6-sec sweep, $N = 60 \times 6 = 360$ lines

Actual vertical resolution is N lines minus the blanked lines, which is approximately 2 lines in slow sweep, times the Kell factor.

Horizontal resolution is limited by the apparent resolution of the long-persistence phosphors of the picture tube and the length and electrical characteristics of interconnecting lines to remote receivers. Resolution as a function of bandwidth is shown in Fig. 1.

Although 500-lines resolution is possible with a 15-kc telephone line, this resolving power may not be apparent with the phosphor of the slow-sweep display tube. An 8-kc

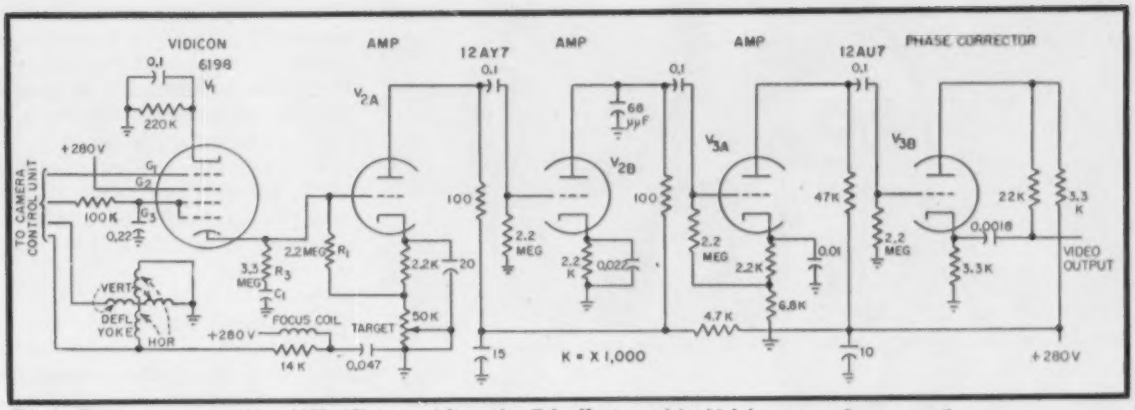


FIG. 2—Slow-sweep camera uses 6198 vidicon as pickup tube. Tube V_{3B} is used for high-frequency phase correction

CLOSED-CIRCUIT USE

line ordinarily allows ample resolution for practical subject matter. Even though Fig. 1 indicates an 8-kc line is limited to about 260 picture elements, the line's roll-off characteristic will permit 300-lines horizontal resolution in practice.

Vidicon Storage

The vidicon signal results from the beam discharge of the target charge caused by the light-patterns imaged by the camera lens on the target area. The output current is proportional to surface potential and rate of scan. The surface potential is relative to amount of light, target potential and storage time. For a given amount of light and target potential, factors of sensitivity are: storage sensitivity; charge-discharge rate per picture element; and beam diameter (maximum number of picture elements).

Since the frame time of slow sweep is much greater than conventional field time and the vidicon increases stored charge during the entire frame time, slow sweep vidicon sensitivity is high relative to conventional television practice. Although offset somewhat by the lower scanning velocity, the charge-discharge rate is about twice that of conventional rate.

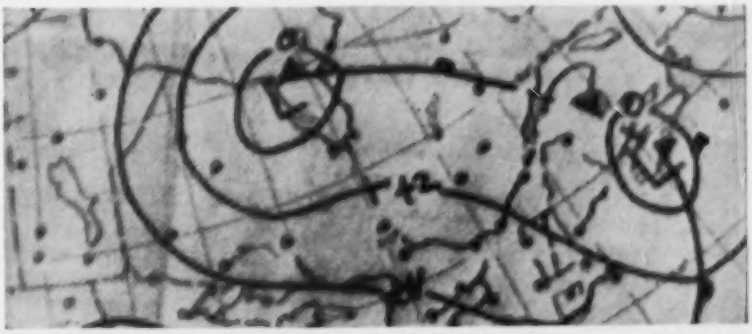
The increase of vidicon storage sensitivity in combination with narrow-band, high signal-noise amplifiers results in a total light-sensitivity gain of approximately 120 over conventional application.

About 200 ft-candles of incident illumination at a target potential of 15 to 30 volts is necessary for optimum studio pictures in conventional practice. With slow sweep, incident illumination as low as 2 ft-candles at a target potential of 15 volts, with the same lens aperture as used for studio practice, is often adequate for excellent reproduction of motionless subjects.

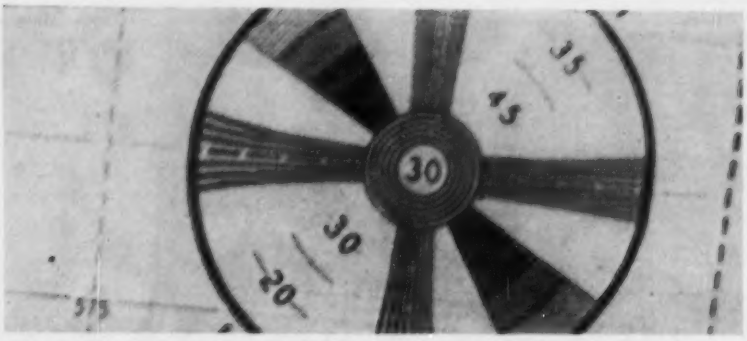
Camera

The camera, shown in Fig. 2, contains a vidicon and two twin-triode tubes, which provide three stages of amplification and a high-frequency phase correction stage.

Direct coupling of the vidicon target to the first video amplifier minimizes stray capacitance in the input grid network. The vidicon output voltage is generated across



Received images on 1-by-3 aspect ratio screen at 2½-second vertical repetition rate



Video signal was transmitted on 8-kc bandwidth line with 20-db attenuation

target load R_1. The potentiometer in the cathode circuit of V_{5A} permits target potential adjustment.

Compensation

Stages V_{2B} and V_{5A} are cathode peaked by small bypass capacitors to compensate for stray capacitance effects at high frequencies and for scanning beam aperture effects. Since beam-aperture effect is equivalent to high-frequency loss without phase error and partial cathode bypassing introduces high-frequency phase shift, phase-corrector stage V_{2B} is employed to compensate for aperture correction.

The phase correction at high frequencies prevents the occurrence of trailing whites after blacks or negative phase distortion. Positive phase distortion black following black is prevented by low-frequency compensation of the target load by R_2-C_1. This compensates low-frequency phase shift occuring particularly from line-transformer characteristics.

Control

Tube V_{1A} in the camera control-monitor unit (Fig. 3) receives the camera video by coaxial line.

The contrast control adjusts the video level fed to line output transformer T_1. Since a transformer output is employed, the receiver used must be connected in proper polarity for a positive picture and correct sync-stripping action.

The signal is further amplified by V_2 to drive the 7ABP display tube. The grid of V_{2B} is clamped on a line-to-line basis by driven diodes D_1 and D_2.

Horizontal-rate pulses control sweep current through the vidicon and picture tube horizontal deflection coils, blank the vidicon at horizontal retrace time and supply horizontal sync information for receiver lock-in. The conventional itv practice of utilizing the vidicon horizontal blanking pulse for receiver horizontal sync is followed.

Cathode - coupled multivibrator V_{3B}-V_{4A}, which generates horizontal-rate pulses, is synchronized by the negative-going edge of a pulsating positive ripple voltage, coupled through the resistor, across clipping diode D_3, from the power supply.

The sawtooth is formed by C_1 and V_{5A}. The vidicon and monitor deflection coils are in series so the saw-tooth current has a uniform trace slope for a given setting of the horizontal linearity control. The vidicon is driven beyond cutoff by the negative pulse at the plate of V_{5A} during horizontal retrace. This same pulse serves as horizontal sync for receivers. The cathode return of the horizontal multivibrator triggers clamps D_1 and D_2 during retrace.

Vertical Scan

Vertical-rate pulses control the sweep current through the vidicon and picture tube vertical deflection coils, blank the vidicon at the vertical rate, blank the picture tube at vertical rate and supply an on trigger during retrace time for the vertical burst oscillator which supplies vertical sync for the receiver. The latter function is the only nonconventional application other than the slow vertical pulse rate.

The vertical pulse is initially generated by plate-coupled multivibrator V_9. The pulse repetition rate is determined by the grid potential of V_{6A} and the cathode potential of V_{9B}. During conduction

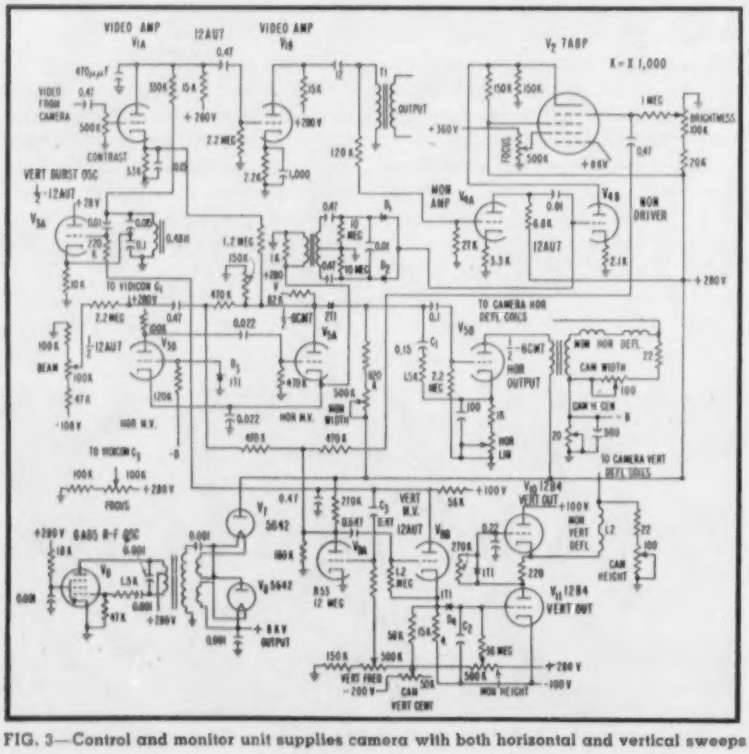


FIG. 3—Control and monitor unit supplies camera with both horizontal and vertical sweeps

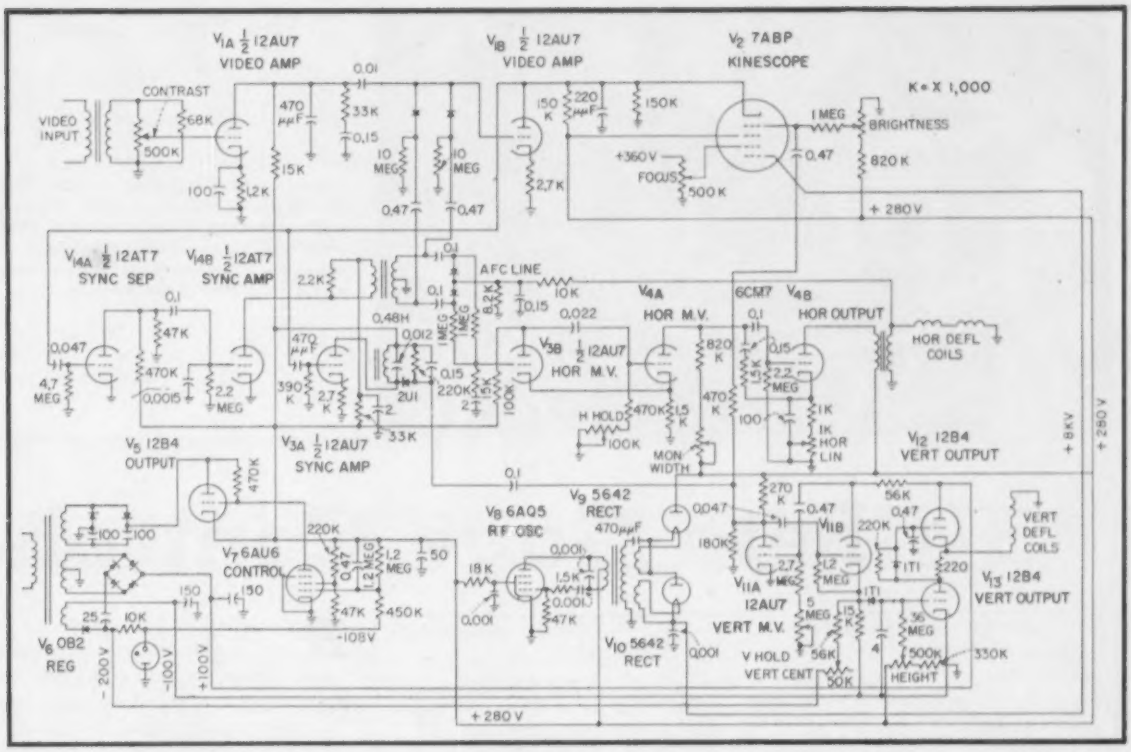


FIG. 4—Receiver resembles control-monitor unit except for inclusion of sync-processing stages and lack of vertical burst oscillator

of V_{5B}, vertical saw forming capacitor C_3 is isolated from the cathode potential of V_{5B} by D_4 and charges toward B+ to form the trace interval. The large capacitance of C_3 charges over a small percentage of the potential supply to utilize only the ultralinear portion of saw formation eliminating need for a vertical linearity control.

Trace Interval

The trace interval end is determined by the monitor height control, which sets the single ended push-pull output driver bias for the vertical deflection coils. When C_3 discharges sufficiently to intercept the grid-cathode cutoff point, V_{5B} is driven to cutoff causing D_4 to conduct. This couples C_3 to the negative potential at the cathode of V_{5B}, discharging C_3 toward the negative voltage.

The retrace duration is determined by this cathode potential that depends upon the setting of the camera vertical—centering control, which determines the point of sweep start.

Centering of the sweep is achieved by permanent magnets arranged concentrically around the picture tube neck and by adjustment of the controls to fill the top and the bottom of the raster. The camera height control assures proper utilization of the target area vertically.

The negative pulse at the plate of V_{5A} during retrace time is coupled to the vidicon grid, as well as the picture tube grid, for vertical-rate blanking of retrace lines. The positive pulse at the plate of V_{5B} is coupled to the grid of vertical burst oscillator V_{8A} to gate on a 2-kc burst which is coupled into the common plate load of video line driver V_{1A}. In the receiver, this burst is separated, by a tuned circuit, rectified and used to deliver triggers to the receiver vertical multivibrator for lock-in. This design eliminates severe system requirements necessary when attempting to use the long frame-rate pulse for direct synchronism at the vertical repetition rate.

Use of the burst-type vertical sync and employment of a driven clamp type afc for horizontal multivibrator control in the receiver, shown in Fig. 4, results in a highly stable picture. It was considered improbable that video or noise signals containing repetitive 2-kc components of sufficient amplitude to upset vertical sync would occur. This theory was proved correct over a long experimental period.

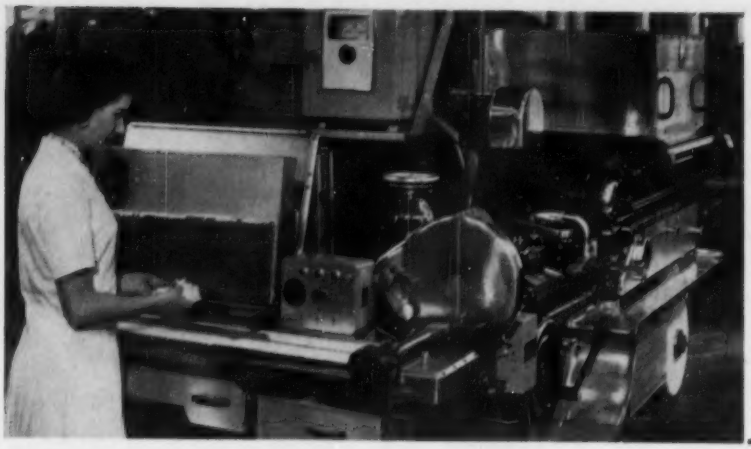
Applications

Records of moderate complexity can be transmitted and reproduced for 15 miles over lines equalized to 8 kc or used to modulate a radio transmitter.

The standard 3-by-4 aspect-ratio unit has a picture size of 4 by 5½ inches. Another unit employing 1-by-3 aspect ratio has a picture size of 2 by 6 inches. The latter size of 2 by 6 inches is for checks and cards in banking applications.

The author is indebted to George H. Fathauer, designer of the slow-sweep system, and Robert Smith for their assistance in checking the manuscript and their suggestions.

The Front Cover



Automatic cigarette-making machine. Main control cabinet at top contains vibrating-reed electrometer fed by beta gage. Regulator control box is directly beneath it while the beta-gage detector is mounted on the right side of the machine

Beta Gage Controls

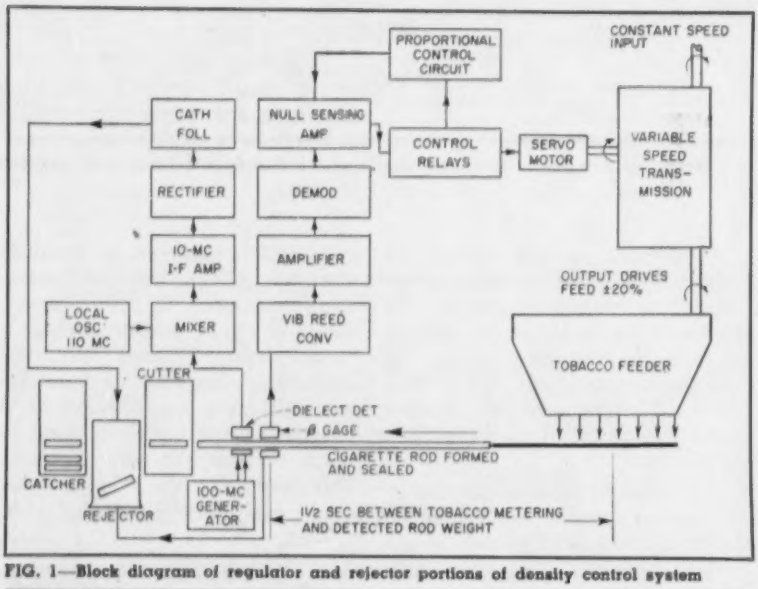


FIG. 1—Block diagram of regulator and rejector portions of density control system

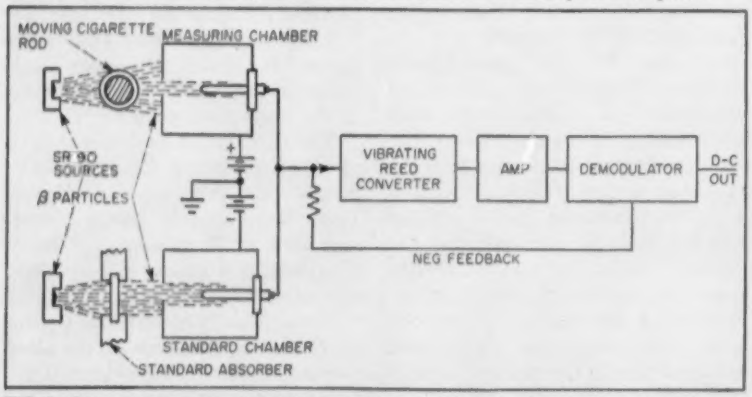


FIG. 2—Beta radiation gage block diagram. Beta-particle beam-density transmitted through cigarette is compared to that transmitted by a standard cigarette absorber

RAG TOBACCO for cigarettes is not homogeneous. It is composed of long strands, short strands, a small amount of dust and stem. To produce a high-quality cigarette, free from loose tobacco, the percentage of short tobacco and dust must be kept low. To do this the tobacco must be treated gently.

The feeding and proper placing of approximately three pounds of nonhomogeneous material a minute in an 11-inch diameter paper cylinder at a lineal speed of 275 fpm is difficult. In filling, short-term variations may result in light or heavy cigarettes, while in feeding, variations of longer duration may run as high as ±15 percent of a desired mean value. This article discusses a servo system that monitors the tobacco density and controls both of these variables.

Short Term Variation

A dielectric bridge controls the short-term variation by triggering the rejection of individual defective cigarettes. A beta-particle gage governs tobacco flow to minimize long-term variations. An overall view of the cigarette-making machine shows the beta-particle measuring head, the control box and the main control cabinet. Figure 1 is a block diagram of the control units of a cigarette-producing machine and their associated circuits.

Rapid measurement of rod den-

SUMMARY —— Combined use of beta radiation gage and dielectric bridge controls both short-term and long-term variations in firmness and density of cigarettes made by automatic machine. Dielectric bridge measures cigarette-rod density automatically to reject cigarettes outside tolerance limits. Beta gage controls tobacco feed

By E. HARRISON, JR.
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Raleigh, N. C.

CIGARETTE MACHINE

sity is made with a pair of electrodes between which the rod passes before being cut into individual cigarette lengths. These electrodes form one leg of a bridge operating at approximately 100 mc. The bridge output is converted and amplified at 10.7 mc in a conventional superheterodyne system. The 10.7-mc signal is rectified and filtered.

The final dielectric measurement appears as a d-c voltage, varying about some mean value, having a magnitude of one volt for a 1 percent variation in rod density. Since this system of dielectric measurement is not highly sensitive to slow variations in tobacco moisture content, supplementary detecting equipment must be used to achieve the required accuracy.

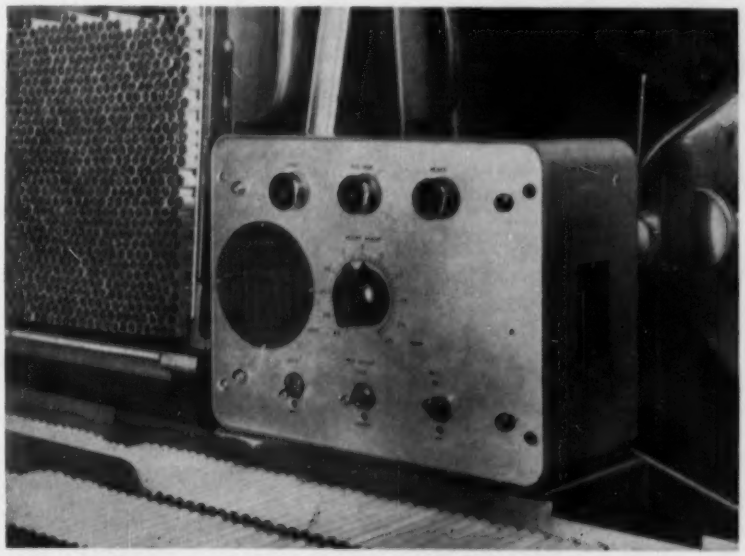
Control

The necessary degree of control is obtained by subjecting the moving rod to a constant beam of beta particles and measuring the number as well as the energy of the particles that pass completely through the rod. This method of measurement was chosen because it has inherent advantages of simplicity and reliability.

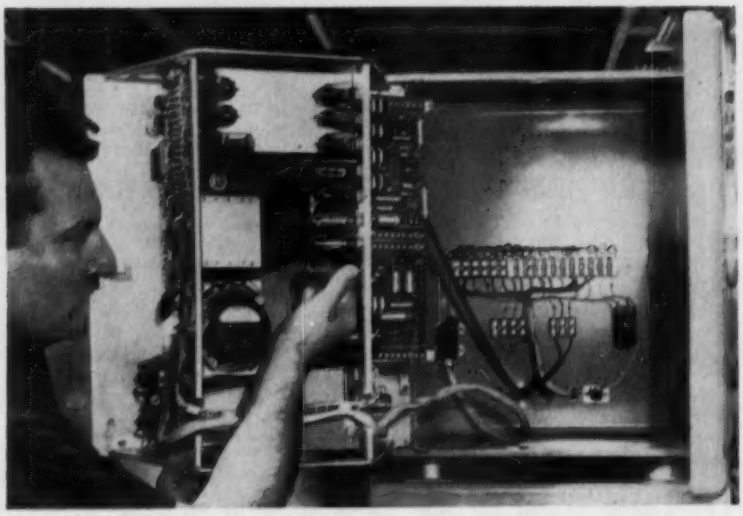
The beta-particle source, radioisotope strontium 90, is placed so that the emission is properly collimated through the cigarette rod. Figure 2 shows the ionization chambers and a block diagram of the converter, demodulator and amplifier circuits. Particles that penetrate the rod pass into an ionization chamber and produce an ion current that is directly proportional to the number and energy of the transmitted particles but inversely proportional to the density of the rod.

This ion current is compared to the current produced by a similar standard source-chamber which includes a fixed absorber of density equal to a portion of the perfect cigarette rod. An adjustable trimming absorber is included for precisely setting the desired operating balance point. The two opposed ion currents are applied to a resistance of about 10^{10} ohms and the resulting voltage is chopped, amplified and fed to a phase-sensitive detector which yields an output voltage of polarity and magnitude corresponding to the true density of the rod.

This output voltage is zero at the desired mean value. The polarity is positive when density is above the desired value and negative when



Control box houses automatic and manual control switches, indicator lamps, alarm bell and weight-control potentiometer



Interior view of control cabinet shows easy access to components

below. The magnitude is adjusted to one volt for 1-percent deviation.

Since the time constant of this system is long, the highest obtainable frequency is approximately two cycles a second. Such a signal cannot be used for rejection of individual off-weight cigarettes, but is ideal for controlling the tobacco feed. This slowly varying signal is also used as a reference for the output of the dielectric measurement system and as such compensates for the slowly shifting error resulting from moisture variation.

Dielectric Measurement

The general arrangement of the dielectric measuring system is shown in Fig. 1. Electrodes and a bridge box are located in the measuring head. The bridge box contains the local oscillator, the mixer with its associated output circuit and the bridge elements.

The total capacitance of the measuring arm of the bridge is approximately 8 $\mu\mu$f, of which 7.7 $\mu\mu$f is residual. The dielectric material in the cigarette rod constitutes only 0.3 $\mu\mu$f. Since it is desired to measure increments of 2-percent variation in the rod with reasonable accuracy, the bridge must not only be stable but also highly sensitive to capacitance changes in the order of 0.006 $\mu\mu$f.

The error resulting from moisture variation in the tobacco is approximately a 10-v signal for a 1-percent change with an average moisture content of 12.5 percent. This error is a slow variation ranging from 1 to 5 v an hour.

To obtain the required stability, considerable attention was given to the bridge box. The assembly is built around a heavy brass casting and all appropriate parts are silver plated. Subminiature dual triodes are used in both oscillator circuits.

Temperature-compensating ceramic capacitors maintain constant frequency with the result that after a two-hour warmup the drift is negligible. The mixer is a germanium diode with a miniature iron-core transformer coupled to a 51-ohm coaxial output line.

The bridge normally functions with the balancing arm adjusted to excessive capacitance. Such a condition facilitates detecting the direction of variation as well as the magnitude. As cigarette rod density increases, the bridge approaches balance and the output voltage approaches zero. Conversely a decrease in rod density yields an increase in output voltage.

The i-f amplifier located in the main control cabinet, is matched to the signal cable by a cathode-coupled input stage.

Beta-Gage System

Strontium 90 was chosen for the beta-gage measurement system because of its suitable beta-particle energy and its long half-life (25 years). Actually, strontium-90 beta energy is only 0.61 mev, but in the decay scheme, it yields yttrium 90, which has a short half-life (61 hours) and a 2.18-mev beta particle. The latter is used as the density measuring agent.

Ambient air ionization chambers are used both for the measuring and the reference systems. The chambers are located one above the other in the measuring head and are connected by a breather tube for pressure equalization. Construction of the chambers is simple and requires no critical materials.

Phenolic materials are used for the insulating parts and conducting surfaces are formed by painting with a dag dispersion of graphite. Each chamber measures 2 by 3 by 3 in. and has a 0.003-in. polyethylene film window mounted at the point where the beta particles pass into the chambers.

The measuring chamber is polarized +200 v; the reference chamber −200 v. The collector rods of the chambers are interconnected to permit balancing to zero output current at the desired mean rod density.

Electrometer

The electrometer control cabinet contains the principal control circuits for automatic cigarette production. In the electrometer control system, currents of approximately 10^{-10} ampere constitute the signal from the ionization chambers. The electrometer is a vibrating-reed type, driven by a 600-cycle oscillator.

The varying potential obtained from the vibrating reed is applied to a three-stage high-gain resistance-coupled amplifier. The amplifier output drives a phase-sensitive detector using the reed-driving oscillator voltage as a reference. The detector output is filtered and used to drive a cathode follower.

The electrometer system is stabilized by a large amount of negative feedback from the ouput cathode follower to the input resistor. Varying the amount of negative feedback controls sensitivity. Output-signal magnitude is adjusted

to one volt for 1-percent variation in cigarette weight. A six-inch meter calibrated −5 percent/0/+5 percent is mounted on the front panel. This meter normally indicates cigarette weights but is also used for zero setting and checks.

Proportional control is desirable because of the delayed response of the tobacco-feeding system. A correction made to the speed of the tobacco feed does not affect the measuring system until after a delay of approximately 1.3 sec. To maintain control without undue hunting, corrections proportional to the error magnitude are required. The basic regulator is shown in Fig. 3.

Speed Changer

The speed changer is capable of correcting at a rate of 2½ percent a second. While the servo motor is making this correction, the porportional control system develops a voltage at a rate equal to the desired proportional fraction.

A single section R-C filter ahead of the regular grid averages the signals from the beta gage.

The null sensing relay is connected between the cathodes of the regulator triode section V_1 and the proportional control triode section V_2. Any unbalance between the two cathodes will cause the relay to operate in the direction of the unbalance. The delicate contacts on the null-sensing relay remove negative bias from the relay tube grids causing plate circuit relays to operate. These plate circuit relays have two sets of interlock contacts to energize the speed changer servo motor for proper rotation and the proportional control circuit.

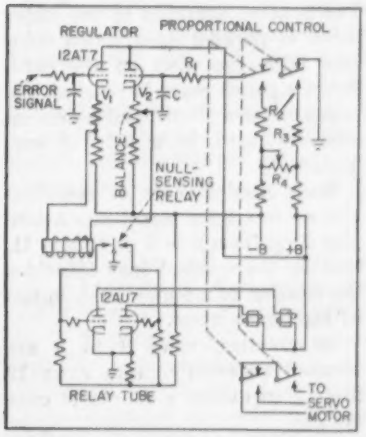


FIG. 3—Regulator circuit converts beta-gage error-signal to servo control signal for tobacco feed regulator

The grid of V_2 is fed by the voltage developed across C by current from the proportionality adjustment potentiometer R_4 through the relay contacts and R_2 or R_3, depending on which polarity is required. Capacitor C discharges through R_1 and the normally closed relay contacts to ground. The charging time constant is approximately 16 sec. The discharge or reset time constant is 2 sec.

Relay operation is arranged for positive polarity voltage feedback when the error voltage on the grid of V_1 is positive, and negative polarity feedback when the error is negative.

The voltage applied to the grid of the proportional control triode is the same polarity as the error signal, thus decreasing the current through the null-sensing relay. As the time balance is regained between the cathodes, the null-sensing relay opens, the controlled plate circuit relay closes and the proportional control voltage is discharged or reset. The charging voltage is adjusted by screwdriver control R_4 and once properly adjusted for a given set of conditions is not changed.

This system provides a series of small corrections to the feed, their magnitude depending on the rate of change of the error signal and the proportionality setting.

Rejection

The system for rejecting individual cigarettes must combine the functions of measurement, data storage and electromechanical ejection of the cigarette from the machine output.

Measurement is accomplished by a dielectric bridge with sensing electrodes at the measuring head. The bridge signal is converted, amplified, rectified and compared to the signal from the beta gage. The resulting signal is applied to the data-storage system.

Using the beta-gage signal as a reference minimizes errors in the dielectric measurement and a sufficiently accurate composite signal is furnished for individual cigarette rejection Figure 4 shows the circuit.

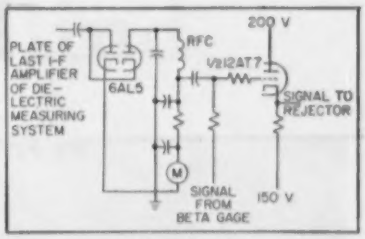


FIG. 4—Signal-combining circuit unites dielectric detector and beta gage signals to prevent long-term drifting

Memory Wheel

Data is stored by a rotating electromechanical magnetic memory wheel, turning at the same rate as cigarette rod travel. The magnetic memory wheel identifies each cigarette and delivers signal pulses at the proper time for accurate rejection.

Physical ejection of individual undesirable cigarettes from a production rate of up to 1,500 cigarettes a minute requires fast action and accurate timing. Upon receipt of an ejection signal from the magnetic memory a thyratron discharges a storage capacitor through the ejector electromagnet. Fingers on the electromagnet armature flip the cigarette into a chute and collecting receptacle.

A weight control makes occasional small adjustments in cigarette weights. For example, it is useful when adjustment of the folder section in the maker is required to correct for out-of-tolerance cross section of the cigarettes. The adjustment range is ±2½ percent from an initial mean.

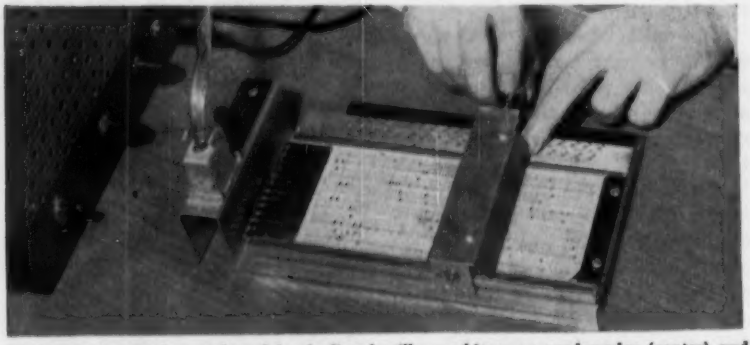
It is necessary to stop the machine periodically to make adjustments, clean the folder section, start a new roll of paper and so forth. The regulator system must be inactivated during these interruptions to prevent changes in the speed-changer setting. By short circuiting the null-sensing relay coil in the regulator when the cigarette rod stops moving, the lockout relay prevents undesirable setting changes and indicates any malfunctioning of the system.

PUNCHED-CARD

By F. DADO, V. PROSCIA and M. RAPHAEL*

Electronics Research Laboratories
Columbia University Engineering Center
New York, New York

SUMMARY —— Both braille and aural-tone indication are provided by punched-card reader to permit blind persons to read any standard punched card almost as rapidly as by visual inspection. Sensing brushes on reader activate one or more of four tones generated by phase-shift oscillators. System opens way to opportunities for blind in accounting, computing and research



Blind operator reads punchcard by feeling braille markings on card-reader (center) and listening to tones from oscillator (left)

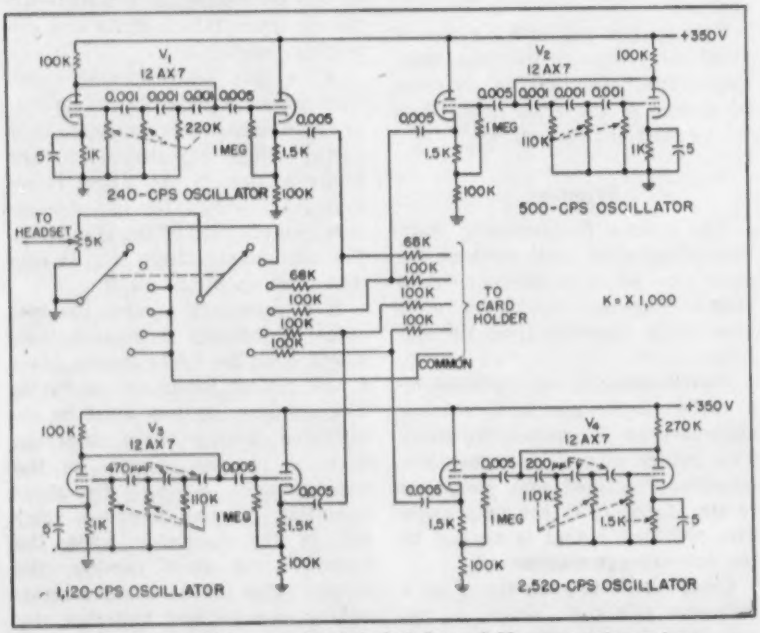


FIG. 1—Phase-shift oscillators consist of dual-triodes and 13 components per tone

THERE has been need for a device to allow blind people to read data from standard punched cards used in business machines, accounting machines and computers. A prototype-model punched-card reader is now in use at the laboratories, which has far-reaching potentialities for employment of the blind.

System Description

The card reader consists of a card holder with a linear braille scale, a gear-driven slider with reading brushes and a coded musical-note indicator, as shown in a photograph.

The holder positions the card firmly in place as the slider is moved laterally across its surface. The brushes attached to the slider move in parallel lines which coincide with the rows on the card. When a punch mark is reached, the brush closes a circuit and a musical tone is heard in a pair of earphones.

Each musical note or combination of two notes represents a definite digit from 0 to 9 or 12 and 11, that is, the musical tone identifies the location of a punch mark in one of the twelve rows.

In practice, rows 0 to 9 are scanned separately from rows 12 and 11 to utilize a four-note code system.

While listening to one of the

* Now with Gruen Applied Science Laboratories, Inc., Hempstead, N. Y.

READER for the Blind

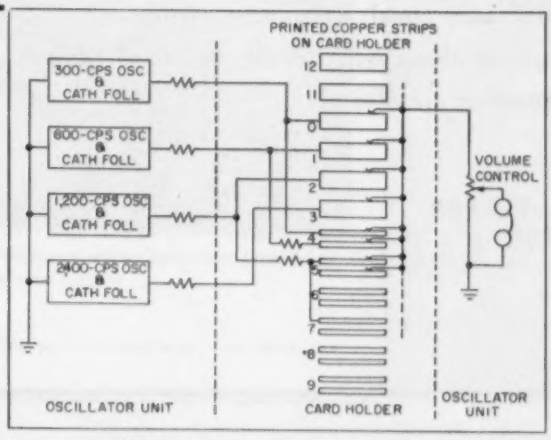
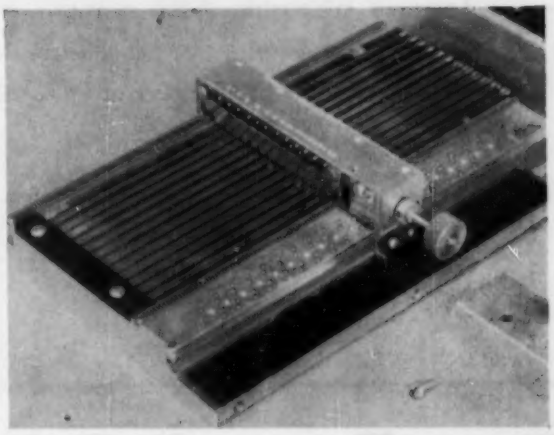


FIG. 2—Simplified representation of method of mixing oscillator tones to provide different volume levels



Closeup of card-reader with cover off carriage shows constructional details. Braille markings are in foreground

notes, the column number is read by tracing a pointer on the brush carrier to a braille scale located on the base of the card holder. This system, therefore, both locates and describes the exact position of a punch mark.

Tone Code

A four-note coded system was chosen to represent any digit which might have been punched in the card. Digits 0, 1, 2, and 3 are represented by single tones and 4 through 9 are double tones; four musical notes being used to identify the numbers from 0 through 9. The best frequencies were found to be about 300, 600, 1,200 and 2,400 cps.

The tones are generated by four separate phase-shift oscillators having cathode-follower outputs, as shown in Fig. 1.

Tone Purity

It was found that a pure note is not necessary to distinguish the different tones; any resulting waveshape from the oscillators is acceptable. In addition, it is not necessary to produce four tones that are exactly an octave apart as long as they are reasonably close to this ratio.

The most important aspect is the relative volume of the tones, especially in the double-note combinations. The lower-frequency tone of a pair of notes should have a greater volume than the higher-frequency tone. The two notes of a pair are more easily recognized in this manner. This requirement involves changing the amplitude of a tone according to the particular number it is to indicate. In the method of combining tones shown in Fig. 2, this proved to be a very simple feature to implement.

The card holder is connected to the oscillator unit by a five-wire cable and cable connector at the card-holder unit. Four of the wires carry the four tones to the card unit and are connected through a switch to the various copper strips on the printed board. This switch allows the reading of rows 0 to 9 or rows 11 and 12. The fifth wire of the cable is the common wire for all the brush contacts and returns the mixed tone from the oscillator unit to the volume control for the earphones.

The potentiometer is used as the volume control and also as part of the mixing circuit for the tones. The resistance in series with the line from each oscillator is split into different parts to provide the different relative volumes required in the double-tone cases. The first resistor in each tone line is in the oscillator unit before the cable.

The particular wire is brought through the switch on the card holder to the copper strips in the rows which require a relatively high-volume output. An additional series resistor is then connected between these strips and those strips requiring less volume.

Controls

The oscillator unit provides the other necessary controls for operation of the entire unit. The six-position switch (Fig. 1) is used to pick the mode of operation. The first switch position is the off position.

The second position is used for normal operation and connects the oscillator to the card holder. The third to sixth positions each disconnect the card holder and provide a single tone to the operator for calibration purposes.

To read a card, the operator moves the brush carriage over the columns to be read. A single or double tone will be heard at each column and will be broken before the tones for the next column are connected.

The device was developed under contract APF 30(635)-2807.

SUMMARY —— Steps required to check tv transmitters for station license or renewal under FCC proof-of-performance regulations are outlined. Frequency spectrum, field strength, visual and aural harmonics, frequency response and noise test procedures are given along with results obtained by one station. Other sources of FCC information are also given

By JESSE R. SEXTON
Chief Engineer
KALB-TV
Alexandria, La.

Proof Of Performance

NEW TV STATIONS filing for a station license after Oct. 1, 1954, as well as all stations filing for renewal of license after that date, must comply with new FCC proof-of-performance regulations.

Letter of Information

The commission's letter of information relating to these regulations contains six parts.

The first three, deal with the performance requirements for color of section 3.687.

It is assumed that the station does not transmit color programs in color, and that its transmitter has been modified to suppress the frequencies indicated in the letter, either by the manufacturer or by installing a kit supplied by the manufacturer. All manufacturers, without exception, make this modification kit available to their customers hence complying with this portion of the requirements is relatively simple.

Part 4 of the letter deals with stations transmitting color programs in color and is not concerned with proof-of-performance tests for stations transmitting monochrome signals.

Part 5 requires data showing overall attenuation versus modulating frequency of demodulated signal for modulating frequencies from 0 to 4.75 mc.

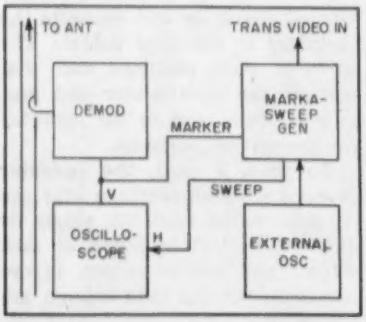


FIG. 1—Setup to obtain attenuation against frequency curves and to measure upper and lower sideband field strength

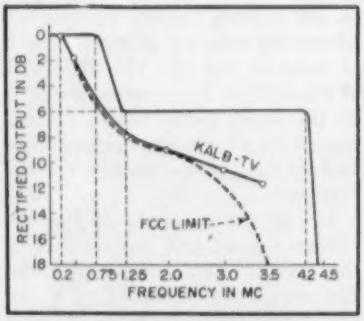


FIG. 2—Curve obtained using setup of Fig. 1 to determine attenuation against frequency for the upper sideband

Further information says the amplitude of the 0.2-mc sideband must be used as a reference point for comparison.

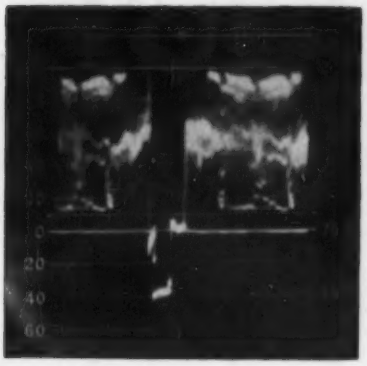
Test Procedure

The equipment is set up as shown in Fig. 1. The test is made with the demodulator probe placed in the coaxial line to the antenna after the harmonic filter and with the transmitter operating into a dummy load. The demodulator is placed on crystal output.

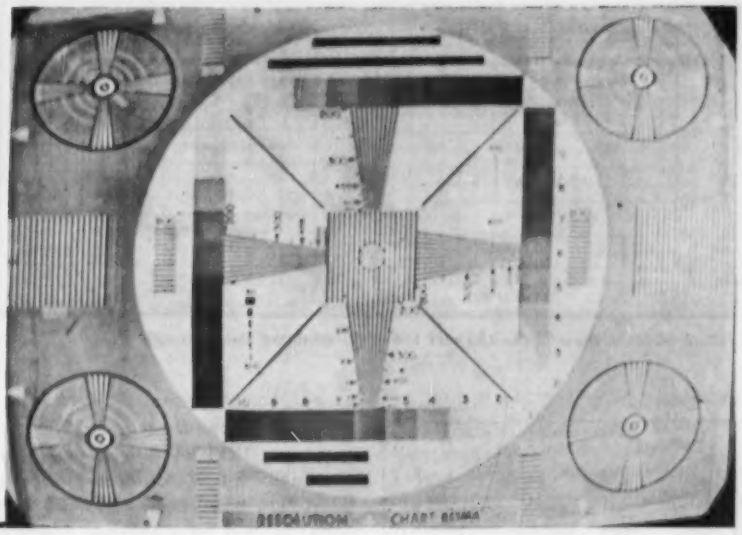
To determine the various levels of the modulating frequencies the screen of a Tektronix oscilloscope must be calibrated in db. This is done by introducing a video voltage with a bandwidth of 0-5 mc from a Markasweep generator into the transmitter video input.

The transmitter is then fully modulated and the amplitude of the signal on the oscilloscope adjusted to a convenient level.

The signal generator is set at 0.2 mc and the marker pip located. The pip will be close to the carrier frequency and near the point of maximum amplitude of the oscilloscope waveform. This point is designated 0 db and a mark is placed on the screen. The sweep generator attenuators are adjusted to add 10 db to the circuit. The



Waveform exhibit taken from face of calibration monitor



Test pattern exhibit taken from the screen

For TV BROADCASTING

level on the scope will drop and the new level is marked—10 db. Additional steps of attenuation are introduced and each new level is marked with the appropriate db reading until the signal is completely attenuated.

The amplitude of the 0.2-mc pip is designated 0 db. Additional frequencies of 0.5, 1.25, 2.00, 3.00 and 3.5 mc are fed into the sweep generator from the signal generator.

Curves

The db levels of the various frequencies are located along the sloping shoulder of the upper sideband and plotted on a curve as seen in Fig. 2.

None of the points should drop below the FCC limit indicated on the curve, for the rules say: "The overall attenuation characteristics of the transmitter, measured in the antenna transmission line after the vestigial sideband filter (if used), shall not be greater than the following amounts below the ideal demodulated curve: 2 db at 0.5 mc, 2 db at 1.25 mc, 3 db at 2.0 mc, 6 db at 3.0 mc and 12 db at 3.5 mc." Should any of these values fall below the limit, it will be necessary to improve the overall linearity of the transmitter.

Field Strength

The second paragraph of Part 5 says: "Field strength or voltage of lower sideband for modulating frequencies of 200 kc to 5 mc and of the upper sideband for modulating frequencies of 200 kc to 8 mc."

Further, information from section 3.687i not included in the above says: "All emissions removed in frequency in excess of 3 mc above or below the respective channel edge shall be attenuated no less than 60 db below the visual transmitted power (or not less than 48 db below the 0.2-mc reference point.)"

In addition, according to section 3.687 (a) (2), the respective channel edges at 1.25 mc for the lower sideband and 4.75 mc for the upper sideband must be attenuated no less than 20 db.

To measure the field strength of the upper sideband, the equipment is set up as shown in Fig. 1. Since levels must be measured 3 db above and below the respective channel edges, a video voltage 0 to 10-mc wide is used to modulate the transmitter.

Sideband

The 0.2-mc sideband is located by introducing a 0.2-mc signal from the signal generator, and is designated 0 db. Additional frequencies from the external oscillator are then fed into the sweep generator and their levels recorded, according to the actual measurements shown in Table I.

The transmitter is swept with a 20-mc-wide video voltage to be sure there is nothing beyond the 10-mc range. In this case there was no measurable signal beyond the 9.0-mc point. The various levels are

AND AS TO COLOR . . .

The information in this article shows how the holder of a monochrome tv broadcast station temporary authorization can obtain a full-fledged station license. Under present rules, no further proof-of-performance is required if station later decides to broadcast color.

It will be necessary, however, to adjust the transmitting equipment for color in conformance with FCC regulations. The tests to insure proper color performance have been described earlier in issues of ELECTRONICS.

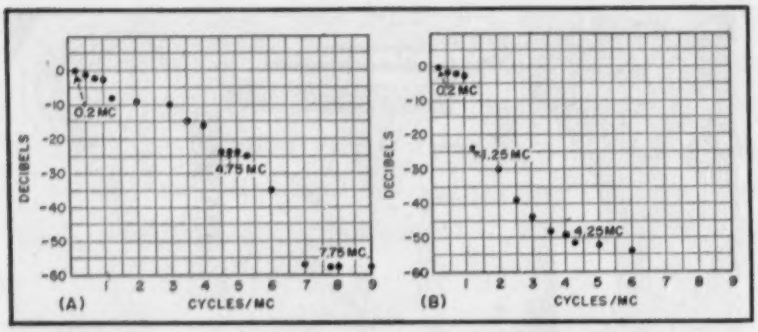


FIG. 3—Curves show upper (A) and lower (B) sideband field strength

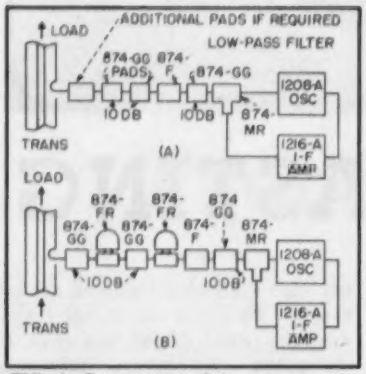


FIG. 4—Setup required to measure carrier fundamental (A) and harmonics (B)

then plotted on a curve, db levels versus frequency as shown in Fig. 3A.

The same procedure is used to measure the lower sideband. The results are shown in Fig. 3B. Since tv transmitters are single sideband, the lower sideband should fall off sharply between 0.75 and 1.25 mc.

Harmonics

The equipment needed to measure both visual and aural r-f harmonics includes the following General Radio types or their equivalents: oscillator 1215-B (50-250 mc), for Channels 2-6; oscillator 1209-B; 874-F low-pass filters; 874-GG loss pads; 1216-A i-f amplifier; 874-MR coaxial element; and 874-FR rejection filters.

Different model numbers of this equipment are necessary for Channels 7-13 and for the uhf channels.

The equipment is set up as shown in Fig. 4. The level of the fundamental carrier is first measured and entered in the appropriate column in the data sheet, a sample of which is shown in Table II. The levels of the various harmonics from the second through the tenth are then taken and entered. Occasionally trouble may be encountered in differentiating between the true harmonic and responses generated in the measuring equipment, especially as the higher frequencies are reached. Questions of this nature can generally be resolved by disconnecting the equipment from the transmission line and noting whether the response disappears or remains.

The actual frequencies of each harmonic are given on the data sheet for each channel. The corrective factors for each harmonic, as shown on the data sheet, are used to arrive at the true db levels. The level of the fundamental carrier is then assumed to equal 0 db and is plotted along with the levels of the harmonics below the fundamental level as computed from the data sheet. Figure 5 shows plots for both aural and visual carriers.

When the measurements are taken, the transmitter should be at full power output and operating into a dummy load. Also, the measurements must be made with the probe placed in the transmission line after the harmonic filters. Each harmonic must be a minimum of 60 db below the level of the fundamental to comply with the requirements.

Photographs

Further requirements concerning the visual section of the transmitter include taking photographs of a waveform and test pattern. The photograph submitted as a waveform exhibit was taken from the face of the calibration monitor waveform oscilloscope being driven from the demodulator and was that of a standard test pattern. In this exhibit it is necessary that the setup interval be shown plainly to be within 2½ percent of the value of 7½ percent set by the commission.

The photograph of the test pattern was taken from the screen of the calibration monitor. It is permissible to use an ordinary home

Table I—External Oscillator Frequencies

Mc	Db Level
0.2	0
0.5	−1
0.75	−2
1.0	−2.5
1.25	−8
2.0	−9
3.0	−10
3.5	−15
4.0	−16
4.5	−25
4.75	−25
5.0	−25
5.3	−26
6.0	−35
7.0	−57
8.0	−58

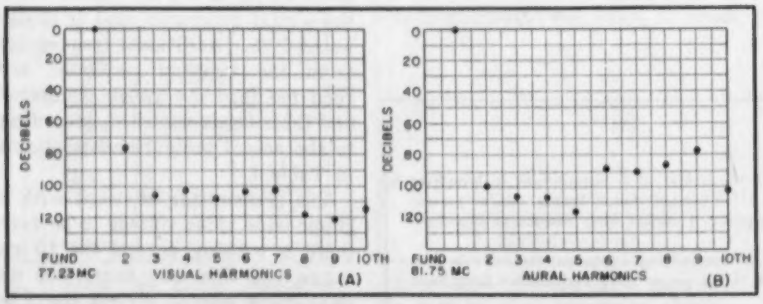


FIG. 5—Plots show level of specific visual harmonics (A) and aural harmonics (B)

tv receiver if the picture shows adequate detail. Requirements are that it show at least 350 lines of resolution and 5 shades of gray.

Aural Tests

For the frequency-response curve, the system must be measured from the studio microphone input to the transmitter output over a band of 50 to 15,000 cps, excluding any limiting amplifiers but including preemphasis. Each point must fall between the limits shown in Fig. 6 and Appendix 3, Fig. 8, Part 3 Rules and Regulations.

To make this test, the equipment is set up as shown in Fig. 7. A loss pad is introduced between the oscillator and microphone input to lower the output of the oscillator approximately 50 db, depending on the type microphone and preamplifier used. The pad should match the impedance of the microphone preamplifier input and the output of the oscillator. It should be made of noninductive resistors and the capacitance between resistors and between input and output leads should be kept as low as possible since small capacitances at higher audio frequencies can result in incorrect readings.

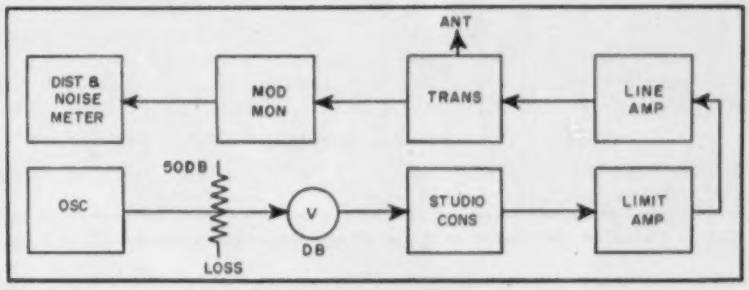


Fig. 7—Setup required to make aural measurements

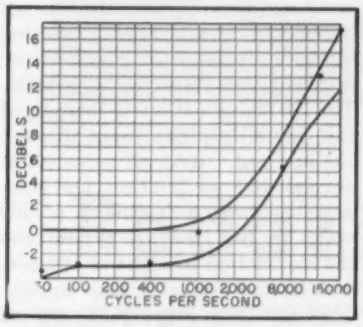


FIG. 6—Limits for frequency response are shown as standard preemphasis curve at top and FCC limit at bottom with specific points obtained between

The db meter should be large and have a scale showing at least —18 to +4 db. Since preemphasis is employed and, to comply with the regulations, the transmitter must be kept at 100 per cent modulation for each reading, it is necessary that the input values not output values be read and plotted. If the input level were maintained at a constant value for each frequency, as is generally done in making amplitude-modulation tests, the output level, instead of remaining at 100-percent modulation, would vary over a wide range owing to the preemphasis.

Frequency Response

A signal of 50 cps is introduced into the microphone input from the oscillator. All gains are set at normal, and any program limiters or compressing devices are removed from the circuit. The oscillator level is adjusted so that the trans-

Table II—Sample Harmonic Measurement Date Sheet

Harmonic	Freq	Set LO	Nearest Spurious Resp-mc	Level A $A_s + A_m$ db	Pads Removed db	Corr for Coupling Loup-db	Corr for Filter db	Level AΘ (A + Corr) db	Harmonic Level AΘ (Fund) AΘ (Harm)
Fund Filt Out	77.25	107.25		70+8.4		0	0	78.4	
Fund Filt In	"	"	−6.4, +17.25	3+5.3		0	0	8.3	
2nd	154.5	184.5	+17.25	6.0		−6	+2	+ 2.0	76.4
3rd	231.75	261.75*	−6.4, +17.25	2.7	−20db	− 9	0	−26.3	104.7
4th	309.0	339.0	+17.25	4.6	−20db	−12	+3.5	−23.9	102.3
5th	386.25	416.25	+17.25	3.0	−20db	−14	+1.5	−29.5	107.9
6th	463.5	493.5	+17.25	3+7.6	−20bd	−15.6	0	−25.0	103.4
7th	540.75	570.75*	−6.4, +17.25	3+7.5	−20db	−16.9	+2.5	−23.9	102.3
8th	618.0	648.0*	−6.4, +17.25	4.4	−30db	−18.1	+3.5	−40.2	118.6
9th	695.25	725.25	+17.25	3.9	−30db	−19.1	+3.0	−42.2	120.6
10th	772.5	802.5	+17.25	3+9.2	−30db	−20	+1.5	−36.7	115.1

*A small spurious response may be found 6.4 mc below the true local oscillator frequency. Set the local oscillator to the higher of the two close responses.

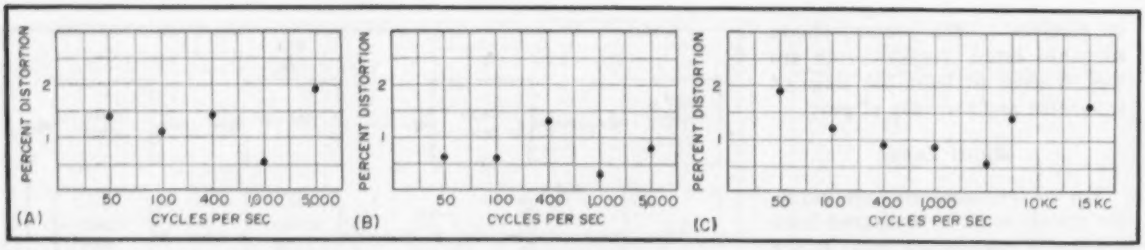


FIG. 8—Plots show distortion at 25 (A), 50 (B) and 100-percent modulation (C) as measured at 100-percent modulation

mitter modulation monitor reads exactly 100 percent.

The signal input meter reading will fall between 0 and +4 db. This value is carefully read and recorded. Without changing gain control settings other than oscillator level, frequencies of 100, 400, 1,000, 5,000 10,000 and 15,000 cps are fed into the system and the level read on the input meter for each frequency. At each frequency the transmitter should be returned to 100-percent modulation.

At 15,000 cps, the input level reading will have dropped off to —16 to —20 db for 100-percent modulation. Since the various input signal levels were read rather than output, the data represents an image of the output. A true curve is obtained by changing the polarity sign of each reading. The frequency response curve thus obtained and must fall between the upper and lower limits of the FCC curve.

There is nothing to prevent shifting the entire curve up or down if doing so will fit it between the limits. For example, if the 50-cps reading is +1 db and the 15,000-cps level falls outside the upper limit at +18 db, the entire curve may be moved downward 1½ db thereby bringing the 15,000-cps reading well within the upper limit while still keeping the 50-cps reading within the lower limit. If the curve will not fit between the limits of the standard curve, then the frequency response of the system is not satisfactory and must be improved.

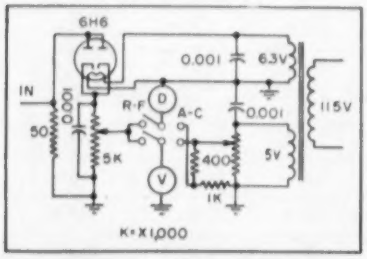


FIG. 9—Recommended method for measuring a-m noise on f-m carriers

Distortion

Distortion must be measured at 100-percent modulation for a frequency band of 50 to 15,000 cps and at 50-percent and 25-percent modulation for a frequency band of 50 to 5000 cps. The distortion levels must not rise above the following values: 50 to 100 cps 3.5 percent; 100 to 7,500 cps 2.5 percent and 7,500 to 15,000 cps 3.0 percent.

The test set up is shown in Fig. 7. A signal of 50 cps from the oscillator is fed into the microphone input. With all gains set at normal, the oscillator input level is adjusted for a 100-percent reading on the modulation monitor. The amount of distortion is read from the distortion and noise meter and recorded. For 100-percent modulation this is repeated for frequencies of 100, 400, 1,000, 5,000, 7,500, 10,000, and 15,00 cycles per second. For 50 percent and 25 percent modulation, frequencies of 50, 100, 400, 1000, and 5,000 cycles are used. The results are shown in Fig. 8.

Noise

In a frequency modulated transmitter, there are two inherent types of noise—that which modulates the carrier frequency and that which modulates the carrier amplitude. Both must be measured. The f-m noise level, in the band of 50 to 15,000 cps, must be at least —55 db below 100-percent modulation. The amplitude noise level must be down —50 db below 100 percent modulation. Measuring the f-m noise level is relatively simple. The a-m noise level presents considerably more of a problem.

To measure the f-m noise level the video transmitter is shut down, since as yet the commission has not taken into consideration noise that might be introduced into the aural section from the visual portion. The oscillator output is introduced into the microphone input through the loss pad. With all gains set at normal and no limiting nor compression used, a frequency of 400 cycles is fed into the system and the modulation brought to 100 percent by the oscillator gain control. The oscillator signal is removed and the noise level read directly from the distortion and noise meter. This is repeated for a signal of 1,000 cps.

At present there is no equipment on the market to measure the a-m noise level of an f-m transmitter. Figure 9 shows a schematic of the method recommended by RCA for their f-m transmitters. An r-f voltage from the transmitter is introduced at the circuit input.

The amplitude of the rectified r-f is adjusted by the potentiometer until a reading of approximately 4 v is obtained on the voltmeter, with the switch in the r-f position. The switch is then placed in the a-c position, and the a-c amplitude adjusted until it is exactly the same as the rectified r-f reading on the voltmeter. The noise and distortion meter is then calibrated to 0 db. The switch is then thrown back to the r-f position, and the a-m noise level read from the distortion and noise meter.

The author acknowledges the assistance of E. Miller, E. Love, and R. Richardson.

Thirty-target radar simulator is used in training personnel for the Army's Missile Master computers. These operators use photoelectric light guns placed against display console to enter targets in electronic tracking system

Radar Simulator Trains MISSILE-MASTER Crews

By GEORGE W. OBERLE

Staff Specialist on Digital Computers
The Martin Company
Baltimore, Maryland

SUMMARY —— Special-purpose digital computers working in real time have been designed to receive radar data and other information and issue orders to guided-missile and other antiaircraft batteries defending an area. The 30-target radar simulator described is used to train personnel working with the Missile Master antiaircraft fire-control computer

TESTING AND EVALUATING ground-based systems involving radar and the training of personnel to operate these systems generally require numerous and costly aircraft flights.

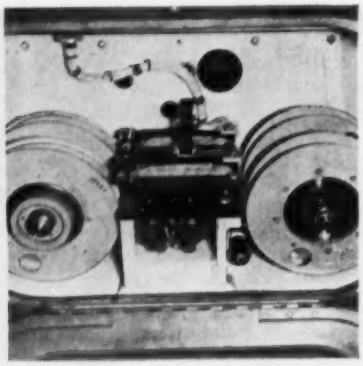
The radar simulator was developed for use with an antiaircraft defense system. Without the use of actual aircraft, it provides for training personnel in the operation of the defense system, routine maintenance and checking procedures, precision testing of certain automatic equipment and partial evaluation of the defense system.

The simulator generates realistic radar video signals similar to those obtained from one search and two height-finder radars for up to 30 aircraft following a predetermined raid pattern. The simulator may be synchronized with the main bang and azimuth scan of an actual radar, or the radar may be completely simulated.

Each target flight path is broken into straight lines and arcs of circles. Target heading, velocity, acceleration and rate of turn at the beginning of each course segment are supplied to a digital computer. Point-by-point calculations of the polar coordinates of the target at 0.2-second intervals are made by the computer and recorded in binary code on 1-inch paper tape.

The system is shown in Fig. 1A. The primary sections of the simu-

Thirty-two-tape reader provides input to radar target simulator



Two-tape reader is used in error detection scheme for simulator

lator are the input tape reader and associated equipment, one video generator for each target, the radar parameters simulation unit and the video mixer and modulator.

The tape reader, shown in a photograph, is capable of reading 32 tapes, maintaining all tapes in synchronism. The starting time of each tape may be individually controlled so that target courses may be staggered with respect to each other by preselected periods. The tape reader employs vacuum sensing of the tape holes, with resulting long life of the tapes.

Video Generators

The heart of the system is the bank of 30 video generators. The inputs to each generator consist of instantaneous binary code values of range, azimuth and elevation coordinates for one target and simulated radar parameters: azimuth beam position, azimuth beam width, elevation beam width and timing signals for the simulated echo generation.

The output of each video generator consists of constant amplitude pulses proportional to target size, delayed from the simulated radar main bang by a time corresponding to the target range and occurring only when the radar and target azimuths agree. This signal would be obtained from an omnidirectional radar transmitter and a scanning narrow-beam receiving antenna with no transmission attenuation.

The signals from the 30 video generators are mixed in a non-additive mixer. The composite signal is then amplitude modulated by a saw-tooth synchronized with the radar main bang to simulate the effects of range attenuation. The composite signal is also modulated by artificial noise and random fading to produce realistic radar video output.

All of the simulated radar outputs except the video are generated in the radar parameters section. The main bang signal is a continuous train of pulses with width and repetition rate corresponding to the radar being simulated.

The main bang is sent to the equipment in the defense system and to the monitor console in the simulator. In composite operation with an actual radar, the generation of simulated video is synchronized to the actual radar main bang.

A shaft representing the radar antenna shaft is driven by a motor at a speed corresponding to the azimuth scan rate of the simulated radar. Synchros connected to this shaft supply radar azimuth information to the defense system.

The position of the shaft is converted to pulse-position modulation to supply radar azimuth to the video generators.

Figure 1B shows a video generator. The *D*-register converts the target range in binary code from the tape to a recurring pulse train occurring at the radar repetition rate and delayed from the radar main bang by a time proportional to target range.

Binary Conversion

The target azimuth and elevation are converted from binary code to ppm by the *A* and *E*-registers, respectively. Target azimuth and elevation are compared with the instantaneous radar azimuth and elevation by coincidence gates.

When the target is within the radar beam, the outputs of the coincidence gates permit the *D*-register output to pass the output gate. This output is the idealized video for one target. Since the angle comparisons are in ppm, the box-car circuits remember the coincidences from pulse to pulse.

Figure 2A shows the *D*-register. One input is a train of 8,192 pulses spaced 0.25 microsecond apart and synchronized with the simulated radar main bang. The other input is the target range in binary code

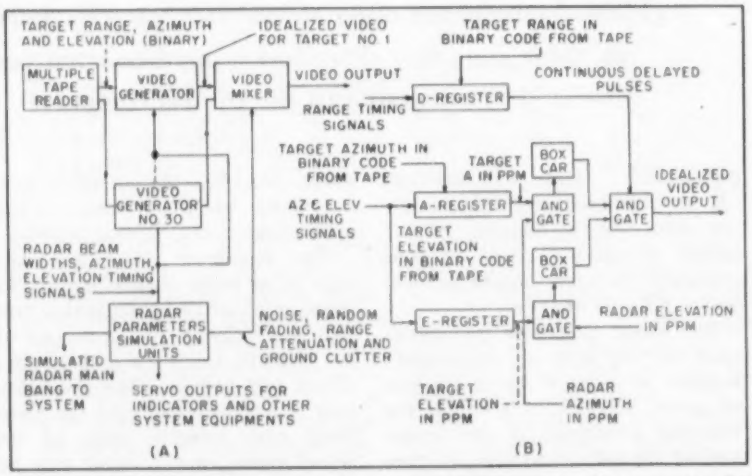


FIG. 1—Block diagram of radar target simulator (A) and one of 30 video generators (B)

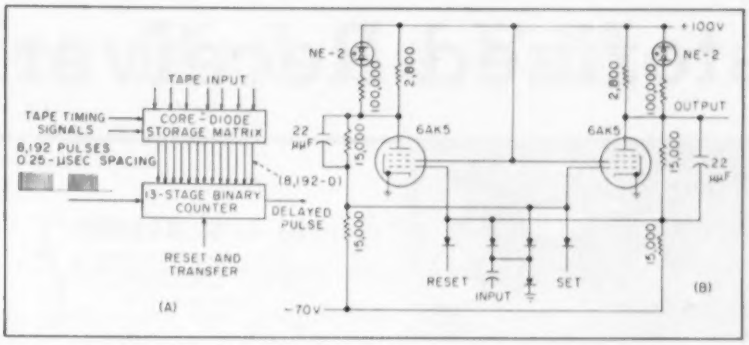


FIG. 2—Main units of *D*-register (A) and circuit diagram of 4-mc counter stage (B)

from one of the tape readers. A core-diode storage matrix selects the D information from the tape reader.

During the dead time between the end of one pulse train and the next radar main bang, the 13-stage binary counter is reset to zero and the D information is transferred from the core-diode matrix to the counter. The number actually set in is 8,192 $-D$, the complement of the target range. When the counter has counted D pulses of the pulse train, the counter goes through zero, producing an output pulse delayed by D units of time from the start of the pulse train.

The counter continues to count the remainder of the pulse train and after the 8,192nd pulse the counter will again contain 8,192 $-D$. Thus each succeeding pulse train will produce an output after D units of time.

New D information is obtained from the tape at 0.2-second intervals. Each new D value is inserted into the counter during the first dead time occurring after the information is ready. A stage of the 4-mc binary counter is shown in Fig. 2B.

PPM Comparison

At the time the simulator was being designed, satisfactory techniques for conversion of shaft position to binary code had not been developed. Digital comparison of target and radar azimuths and elevations was therefore abandoned and the ppm comparison technique was selected. The conversion of target azimuth to ppm, is accomplished in the same way the D signals are generated.

However, there is no connection between the D pulse train and the azimuth pulse train. The output of the A-register is a pulse delayed from the start of the A pulse train by a time proportional to target azimuth.

A potentiometer on the simulated-radar shaft produces a d-c voltage proportional to the radar azimuth. This voltage is compared to a saw-tooth voltage starting in synchronism with the beginning of the A pulse train.

When the voltages are equal an output pulse is produced. The pulse produced is delayed from the beginning of the A pulse train by a time proportional to the radar azimuth.

The width of the target and radar azimuth ppm pulses correspond to one-half the radar beam width, so that coincidence is obtained whenever target and radar azimuths agree within ± one-half of the beam width.

An important feature of the simulator is error detection. A separate tape reader shown in a photograph provides range, azimuth and elevation for one target on one tape and corresponding x, y and h coordinates for that target on another tape. The D, A and E coordinates are used to generate simulated radar data which goes to the defense system.

Certain automatic equipment in the defense system using the radar video produces x; y and h coordinates which should agree with the target coordinates. These data occur in d-c form and in pulse code modulation.

The x, y and h coordinates from the tape are subtracted in the error detector from the coordinates generated in the defense system. The x, y and h error signals are recorded on three recorders for future reference.

Azimuth Bias

Another feature of the simulator is azimuth bias with which the azimuth of a target may be changed by any selected angle. Each azimuth register is provided with a set of switches with which a constant angular displacement may be added to the target azimuth.

The number represented by the toggle switch is added to the target azimuth each time new information from the tape reader is put into the A register. The combination of this feature with the staggered starting of tapes permits a wide variation in raid patterns to be obtained from a set of punched tapes.

Additional Targets

Additional targets are obtained by generating one or two additional pulses from the outputs of individual D registers, but delayed from the D output. Two phantastrons associated with each D register permit adjustable delayed echos.

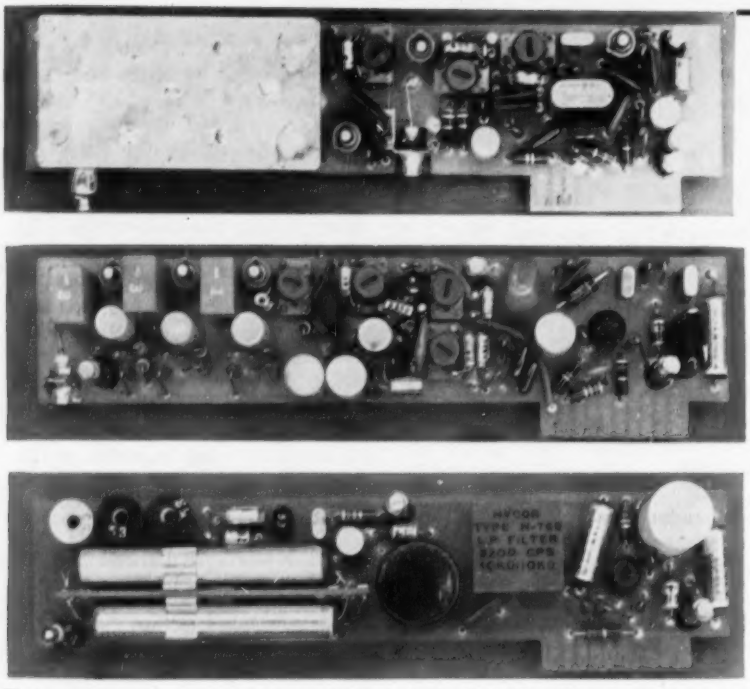
These additional targets appear at the same azimuth as the target from which they are derived. The addition of 60 screen-coupled phantastrons permits generation of up to 90 simulated targets.

Individual targets may be selected to produce iff responses or jamming signals of various kinds.

Ground clutter is simulated by mixing into the simulated video the output of a conventional video mapper scanning a pattern taken from an actual radar.

The various target and radar parameters are controlled from the control console including the tape reader and vacuum pump, radar beam widths, radar azimuth scan rate, radar repetition rates, individual target size and dump controls, type of noise selection and selection of iff responses for selected targets. One range-height indicator and one ppi are provided for monitoring the simulated video outputs.

Transistorized Receiver



By A. M. BOOTH*

Chief Design Engineer
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Three-section receiver consists of an r-f chassis (top) with 12.5-mc filter in metal can, an i-f chassis (center) and audio chassis (bottom) with three power transistors at upper left

SOME MILITARY vehicular communications require a reliable transistorized 12.5-mc f-m receiver, capable of being mass produced without special selection of components. The receiver described here is coupled to an electron-tube variable-frequency tuner to provide a receiver covering the 20 to 70-mc band. The 12.5-mc i-f signal produced by the tuner is used as the r-f input to the fixed-tuned transistor receiver.

Auxiliary circuits provide a squelch relay, a beat-frequency oscillator, and a 1-mc crystal calibrator. All electrical components are designed for printed-circuit wiring and dip-soldering techniques, except the 1.3-mc selectivity filter.

Sensitivity is 12 microvolts into 50 ohms for a signal plus noise-to-noise ratio of 10 db. A 100-μv signal into 50 ohms is the minimum required to drive the receiver to a rated 500-mw output with a 600-ohm resistive load. A 12.5-mc signal modulated at 1,000 cps with 15-kc deviation is considered standard. Estimated average power consumption is 1.2 watts under normal voice-operating conditions.

Standby current drain is 37 ma with a 26-volt battery supply. Full output is obtained at approximately 100-ma current drain at 26 volts.

The unit is capable of operating without degradation in performance over an ambient temperature range of -67 F to $+149$F with a simultaneous battery voltage variation of 22 to 30 volts.

The mixer, i-f and discriminator circuits are shown in Fig. 1. A 12.5-mc r-f selectivity is achieved by a 6-section L-C band-pass filter of a modified constant-K type. A bandwidth of 250 kc to 1,000 kc for the 6-db/60-db points provides 85-db attenuation for spurious frequency responses outside the $\pm$200-kc points of the 12.5-mc r-f reference frequency.

The local oscillator employs a 11.2-mc series-resonant crystal as a feedback network between the tap on the collector tank coil and the emitter. This unit has a frequency-stability of $\pm$0.007 percent for a simultaneous voltage variation of 22 to 30 volts and temperature change of -67 F to $+$ 149 F.

A 6-volt Zener diode is used for supply voltage and mixer bias regulation. Voltage change across the diode is 0.1v with a supply variation of 22 to 30 volts.

Mixer

The mixer circuit is of the common-emitter type producing approximately 12-db of conversion gain. Single-tuned circuits are used for ease of production alignment and field maintenance. To provide the required bandwidth it is necessary to sacrifice conversion gain by impedance mismatch in the collector circuit. For narrower bandwidth requirements, conversion gains of approximately 20 db would be realizable.

The first 1.3-mc i-f amplifier is located on the 12.5-mc r-f chassis as an aid in testing for normal r-f unit conditions with a standard vtvm. It has a bandwidth of approximately 600 kc to avoid attenuation of the response curve of the 1.3-mc selectivity filter.

The selectivity filter serves as the output unit for the r-f chassis and the input unit for the i-f chassis. A 12-section L-C band-pass filter of modified constant-K type is used. It establishes the entire 1.3-mc i-f system selectivity and has a bandwidth of 100 kc to 200 kc for the 6-db/60-db points.

* Work done while with Crosley Division, Avco Mfg. Co.

for Mobile F-M

SUMMARY —— Mobile f-m receiver with nineteen transistors is designed for mass production using printed circuits and available transistors. Circuit operates over temperature range from −67 F to +149 F with simultaneous supply voltage variation from 22 v to 30 v without degradation

Each of the parallel-tuned circuits is set on the high-side 60-db cut-off point. These are coupled with a capacitor which series resonates with the parallel-tuned tanks to the low-side 60-db cut-off point.

The input and output load resistances were chosen to be 5,600 ohms so that the values of L-C would be of practical size.

I-F Amplifiers

Three stages of 1.3-mc amplification employ fixed single-tuned transformers eliminating production tuning and simplifying field maintenance. These are designed for a collector load to input impedance ratio of 5,000 to 1,000 respectively. A deliberate mismatch was required to realize an overall 320-kc bandwidth at the 6-db points for the three stages. This bandwidth prevents excessive attenuation of the 1.3-mc selectivity filter characteristic.

A 5,000-ohm collector-load impedance was chosen so that a fixed tuning capacitance of sufficient value could be used to minimize the detuning effects of the variation of C_o of the transistor and wiring capacitance. The surface barrier SB-100 transistor is used because of its 2 to 3-$\mu\mu$f value of C_o and the small change in value with voltage variation.

The three interstage transformers are encapsulated so that they can be inserted directly into the printed-circuit board. The windings are coated with a cement prior to resin encapsulation. This reduces the capacitance effect of the encapsulating material. Changes in the type of encapsulating material also require a change in the fixed-tuning capacitor due to variations in added capacitance effects.

Limiter

Limiter action depends primarily on collector-to-base voltage satura-

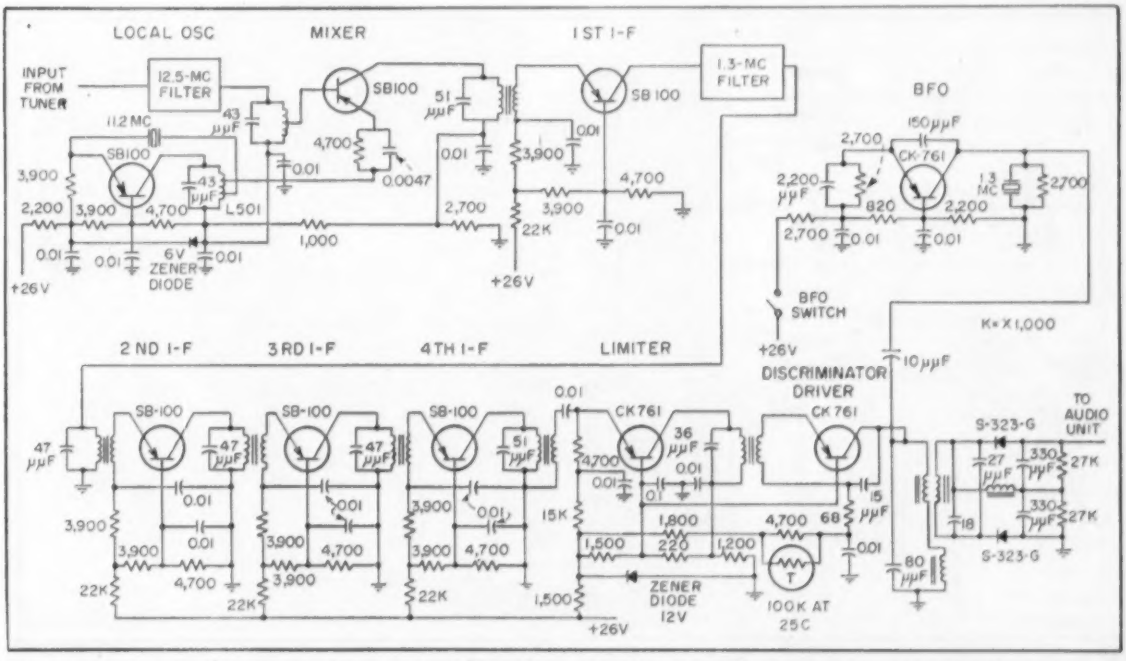


FIG. 1—Mixer, I-f and discriminator sections of f-m mobile receiver. Input to this section is from electron-tube variable tuner

tion. The emitter bias is 300 μa and collector-to-base d-c voltage is 1 volt. A 12-volt Zener diode stabilizes bias conditions for both the limiter and discriminator driver. The gain of this stage is approximately 8 db at initial limiting conditions and is restricted by the low value of bias. The limiter characteristic curve is flat and well within the specified 1-db requirements for a standard signal input variation of 100 μv to 100 mv.

Discriminator

The discriminator driver power gain is 20 db. The power level is raised at this point to obtain better rectification efficiency of the detector diodes. A conventional Foster-Seeley type is used. Peak-to-peak spacing is 130 kc with good linearity over a 90-kc range.

Audio Amplifier

In the audio amplifier section, shown in Fig. 2, a low-pass noise filter cuts off noise energy above 3,200 cps for 6-db signal-to-noise ratio improvement. Its attenuation characteristic is 12 db per octave above 3,200 cps. Insertion loss in the passband is negligible.

Attenuation of the highs due to preemphasis in the transmitter is produced by the network R_1 and C_1. The 30-db power gain of the deemphasis amplifier compensates for the loss of the network.

A high input impedance is required to avoid disturbing the frequency characteristics of this network and to allow a reasonable value for C_1. The high impedance is obtained by emitter degeneration. High resistance base-biasing resistors are employed to avoid loss; and a low I_{co} transistor is required to maintain stability.

As this stage is the first in the high-gain audio amplifying system, a transistor with low inherent noise is also required.

The audio amplifier section delivers 500 milliwatts output to a 600-ohm resistive load under standard r-f input signal conditions. Total harmonic distortion does not exceed 5 percent for audio signals at 250 to 3,200 cps at 500-mw output. The audio output is flat within ± 2 db at a 200-milliwatt reference level between 250 to 3,200 cps.

Four direct-coupled stages are used with the final two transistors connected in a complementary symmetry circuit. Since this circuit utilizes no interstage transformer it occupies a minimum of space.

Direct coupling permits the use of d-c overall feedback for temperature stabilization. In addition, a-c feedback is employed to stabilize power gain with respect to both temperature and supply voltage changes and also to reduce distortion. The 0.1 μa value of I_{co} for the TI904 silicon transistor was used as a criterion for selecting it as the first audio amplifier transistor. This contributed to overall power output stability at high ambient temperature.

The second audio amplifier transistor is a GT-691 chosen for its power-dissipation rating, relatively low I_{co}, and convenience of direct coupling a *pnp* type to the preceding *npn* type transistor. As used, it supplies the proper impedance match as well as gain.

The 6-volt Zener diode is used as a direct-coupling device to provide an optimum operating bias for the second audio amplifier. This increases the power gain and temperature stability.

The driver and final stages use similar types GT-731 and GT-732 with ratings of 1 to 2.5 watts at 25 C depending upon the size of the heat sink employed. These power transistors were the only available *pnp* and *npn* types having the power ratings needed.

The driver amplifier is common-emitter connected and operates

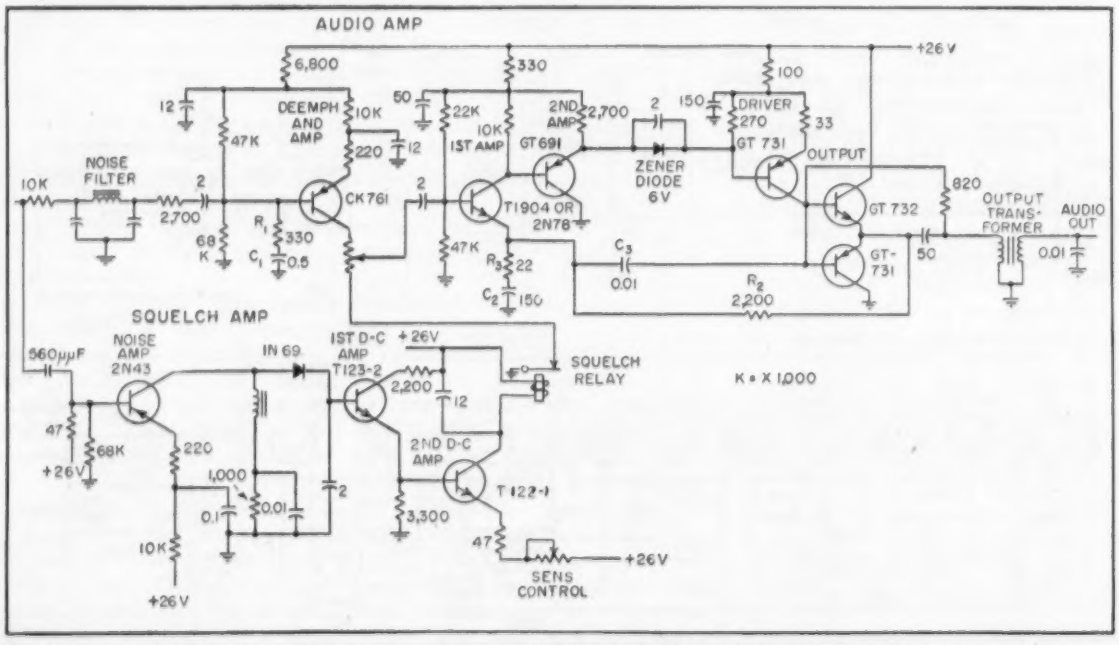


FIG. 2—Audio amplifier with squelch circuit. Operation of squelch relay lifts collector of deemphasis amplifier from ground

class A. It provides power gain and is directly coupled into the final stage.

The final class-B power-amplifier stage consists of a complementary symmetry pair. A common collector connection is employed primarily for its inherently good temperature stability but at a sacrifice of power gain in comparison to common-base and common-emitter connections.

The use of overall d-c feedback for temperature stabilization is provided by a 2,200-ohm resistor in the output feeding back to the first amplifier stage. A change in output current at the emitter junction of the final stage is used to develop the proper corrective bias in the input circuit.

Stabilization of power gain with respect to temperature and d-c supply voltage variations and reduction of harmonic distortion is accomplished by the a-c feedback network of resistors R_5, R_6 and capacitor C_5. Capacitor C_6 eliminates a tendency to regeneration at higher audio frequencies.

Measurements at 500-mw output pass all specification requirements. Values of 1-percent distortion at nominal 26-v supply are common and reproducible. Less than 5-percent distortion is maintained at 75 C operating temperatures.

Replacing and interchanging transistors produce no noticeable difference in performance. Transistors capable of operating at higher temperatures and having lower values of I_{co} would aid greatly in improving this circuit for use over a wider temperature range.

The squelch circuit is operated by the noise level present at the discriminator output. The first amplifying stage is tuned to accept a noise spectrum centered at approximately 25 kc and to reject audio-frequency signals. The noise is rectified and amplified to energize the squelch relay with a pull-in current of 7.5 ma.

At high noise levels, the relay contacts open, lifting the volume control and collector lead off ground in the deemphasis audio amplifier.

When a signal is received the noise level will be reduced and the relay will become deenergized. This closes the contacts and the receiver is returned to normal operation.

Overall sensitivity is such that an equivalent noise input of 0.15-v rms at the discriminator output will produce silencing. A 2½-db reduction of the 0.15-v rms input will unsilence the receiver.

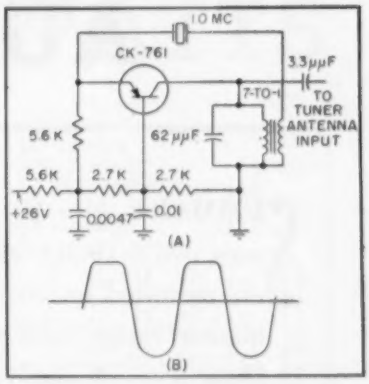


FIG. 3—Crystal calibrator (A) provides 1-mc output. (B) rich in harmonics

Beat Frequency Oscillator

A Clapp oscillator circuit which does not require a tank circuit is used for the bfo. In addition, use of a Zener diode for voltage stabilizations was found unnecessary. A series-resonant 1.3-mc crystal, is employed.

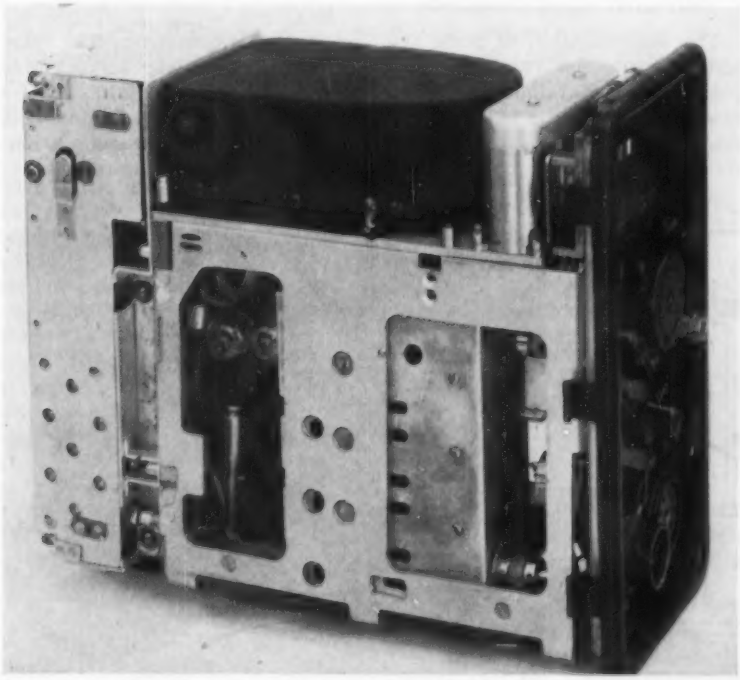
An inherent frequency stability of ±2 cps is obtained for ±20 percent supply voltage variation. Temperature changes from −55 C to +85 C produce a ±60-cps frequency change. This easily meets the stability specification requirement of ±0.02 percent (±250 cps) for the bfo.

Crystal Calibrator

A 1-mc crystal oscillator shown in Fig. 3A is employed for calibrating 1-mc interval points on the 20 to 70-mc tuner dial.

An output sufficiently rich in harmonics is generated by overdriving the junction-type CK-761 transistor to produce clipping of the output wave as shown in Fig. 3B.

The author acknowledges the assistance of G. Bruck, D. E. Kammer, F. M. Brauer, I. M. Wilbur, H. H. Lenk and W. Worth. The work described here was sponsored by the short-range communications section of the Signal Corps Engineering Laboratory.



Complete receiver with electron-tube tuner. Transistor r-f, i-f and audio sections are in vertical chassis mounted at rear of vacuum-tube unit

AUDIO AMPLIFIER

SUMMARY —— Power amplifier for direct air-to-ground communication uses two 4-1000A air-cooled transmitting-type tetrodes to drive loudspeakers mounted on airplane. Output is in excess of 3,000 watts over a frequency range from 400 to 4,000 cps with less than 2-percent distortion. Hum level of amplifier is 57-db down at full power output

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HIGH-POWER amplifiers are required to provide direct air-to-ground communcations in military operations using a multiple loudspeaker installation on the underside of the aircraft.

The specifications for the power amplifier required that it be capable of delivering 3,000 watts in the frequency range between 400 and 4,000 cycles per second with a distortion not to exceed 10 percent. The amplifier developed was able to deliver the required power with less than 2 percent distortion. The circuit is shown in Fig. 1.

Analysis of available tubes showed that a pair of 4-1000A tubes operated Class B_1 push-pull would be capable of delivering slightly in excess of 3,000 watts within the rated plate and screen dissipation if operated with 5-kv plate supply voltage and 1.25-kv screen voltage.

To develop the permissible peak plate currents without positive grid voltage drive it is necessary to operate the tubes with screen voltages considerably in excess of the values specified for Class AB_1 and B_1 operation.

Plate and Screen Dissipation

The determination of plate and screen dissipation required transposition of the available plate and screen characteristics to values corresponding to the value of screen voltage required for operation in this circuit.

Maximum average plate dissipation, with sine-wave signal, occurs when the plate is driven $\frac{3}{4}$ of the way to zero volts. With 5 kv plate supply and 1.25 kv on the screen this corresponds to a peak a-c signal voltage of 3,333 volts. This results in a peak plate current of 1.27 amperes and an average plate current, for the two tubes, of 0.085 ampere. The d-c input power is 4,025 watts while the a-c plate power developed is 2,115 watts. The maximum average plate dissipation is 1,910 watts.

Maximum screen dissipation occurs at maximum drive. The value of zero-signal plate current was arbitrarily chosen at 0.100 ampere to produce 50 percent of rated plate dissipation. This represents a reasonable compromise between sever-

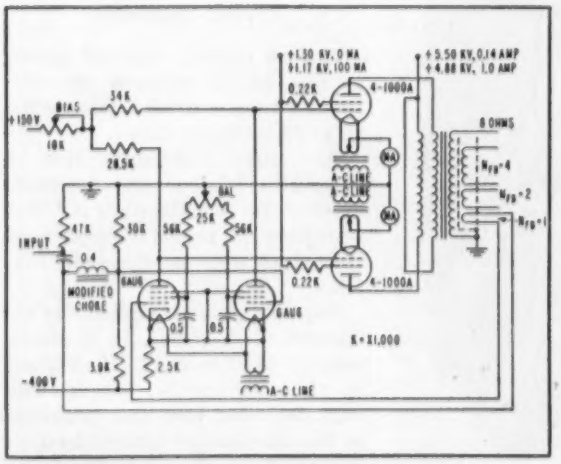
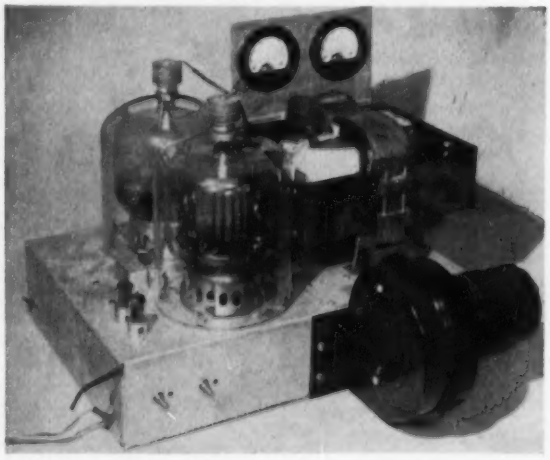


FIG. 1—Push-pull transmitting-type tubes feeding bifilar-wound primary provide 3,000 watts of audio power



High-power audio amplifier is cooled by blower circulating air through glass envelopes surrounding tubes.

DELIVERS 3,000 WATTS

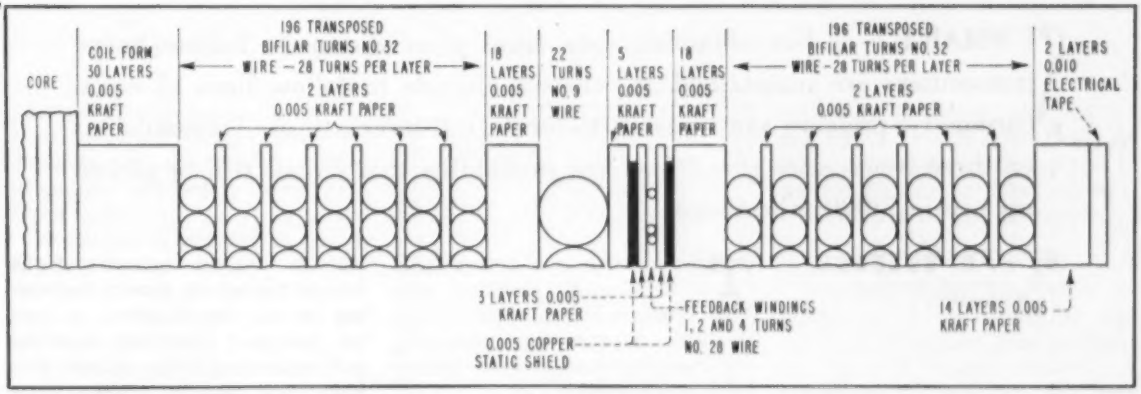


FIG. 2—Cross-section of transformer winding buildup. Output winding is placed between two bifilar-wound sections of primary windings

ity of Class-B bias and quiescent plate dissipation.

Fourier analysis applied to the available operating data yielded the following operating conditions: $I_b = 0.980$ amp, $I_{c2} = 0.118$ amp, screen dissipation = 148 watts, plate circuit input power = 4,900 watts, a-c power developed = 3,040 watts, plate dissipation = 1,860 watts, plate efficiency = 62 percent.

This indicates that the operating conditions chosen will yield the required power output within the plate and screen dissipation ratings.

Transformer Design

Class B operation of the output tubes requires that the output transformer primaries be bifilar wound to avoid the conduction-transfer notch. A feedback winding is closely coupled to the bifilar primary and to the secondary, and statically shielded from them. Good coupling between the bifilar primary and the secondary is assured by dividing the primary into two windings and sandwiching the secondary between them.

There is no d-c voltage between the two primaries but an instantaneous peak voltage of 4,000 volts appears between adjacent points of these windings at full signal. For this application Kel-F insulation had the advantage of 2,500 v per mil dielectric strength.

The wire used for the bifilar primaries was No. 22 wire with 0.014-in. insulation. Twisted samples of this wire were tested with 20-kv peak 60-cycle power without breaking down.

Preliminary calculations indicated that the high-frequency power delivering capacity would begin to fall off at frequencies slightly below 4 kc so it was decided to take advantage of the reduction in primary interwinding capacitance obtained by transposing the bifilar winding at every turn.

The output transformer was designed to be used with two Moloney MA-306 grain-oriented C cores. The winding buildup for this transformer is shown in Fig. 2.

To supply the grid driving voltage required by the 4-1000A tubes without introducing excessive grid circuit resistance, two 6AU6 tubes were used. This also provided d-c balance by adjustment of the 6AU6 screen voltages. The choke in the impedance-coupled input is a Thordarson T20C51 choke modified by full interleaving of the laminations. Three feedback windings of 1, 2, and 4 turns were supplied.

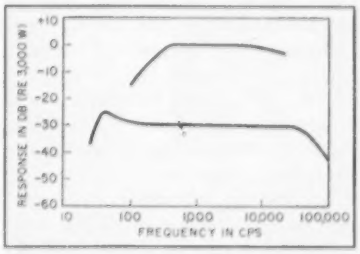


FIG. 3—Frequency response characteristic of 3,000-watt amplifier with input adjusted for 2-percent distortion (upper curve) and input held constant at 0.30 volts (lower curve)

Performance

Operation of the amplifier was stable with the maximum possible feedback of 30 db corresponding to the full seven turns in series. A single feedback turn corresponding to 13 db provided an adequate hum level 57 db below 3,000 watts and only required 8.7-v input for 3,000 watts output.

Plate dissipation exceeded the rated value by 2 percent in the 1.4-kw output region while the screen dissipation remained below the rated value up to full power output. Residual hum and distortion are about 0.8 percent over most of the operating region rising rapidly to 1.4 percent at 3,000 watts.

The frequency response characteristics are shown in Fig. 3. The upper curve shows the 2 percent distortion power delivering capacity. The lower curve shows low-level frequency response characteristic obtained by maintaining constant input voltage while varying the frequency. This characteristic deviates by less than 1 db over a range of 100 to 38,000 cps.

Transosonde Monitors

SUMMARY —— For obtaining data from great distances, balloon-borne transmitters are maintained at constant altitude to follow lines of equal barometric pressure and transmit meterological information. Transmissions on three frequencies give 80-percent probability that signals will be picked up within 3,000 mile range

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Naval Research Laboratory
Washington, D. C.

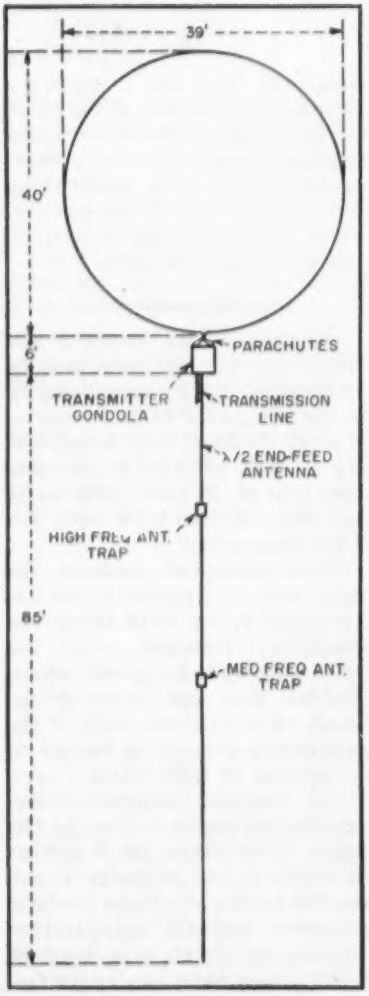


FIG. 1—Flight assembly of transosonde balloon. Traps provide proper antenna lengths for three transmitting frequencies

TRANSOSONDE is a transoceanic meteorological sounding system. It offers a comparatively economical means of obtaining weather information over inaccessible ocean areas.

The system consists essentially of a balloon carrier with altitude control equipment that can be made to float with the prevailing winds along a constant-pressure surface, meteorological sensor, radio transmitter, safety lights and power supply.

A network of radio direction finder stations take position fixes on the balloon at periodic intervals and collect the meteorological intelligence telemetered by the radio transmitter.

The flight trajectory of the balloon provides information on the atmospheric flow pattern. Other meteorological parameters may be telemetered during the programmed radio transmissions for fix determination.

Airborne Equipment

The current flight equipment, as shown in Fig. 1, consists of a helium filled 39-foot plastic balloon, equipment gondola containing radio transmitter, meteorological sensor, flight-control equipment, ballast and safety devices and the antenna system. The complete assembly weighs 600 pounds of which 350 pounds is iron dust ballast material which is dropped as required to maintain the altitude of the balloon at some predetermined pressure level normally 300 millibars equivalent to an altitude of 30,000 feet.

The ceiling or maximum altitude of the balloon is established by the volume of gas in the plastic bag. Should the balloon tend to exceed this ceiling, helium gas is expelled through an open appendix at the base of the balloon thereby decreasing the lift. By adjusting the ballast level to a point just below the ceiling an essentially constant altitude flight may be achieved over long distances.

Transmitters

Three radio transmitters, provide a 50-watt signal sequentially on three frequencies: 6,693 kc, 11,209 kc, and 18,013.5 kc. The frequencies were selected so that there would be a high probability of at least one being the optimum working frequency for the variety of transmission paths and times of day experienced on a flight lasting several days and extending half way around the world. The effectiveness of the 50-watt transmission at three frequencies is shown in Fig. 2.

Transmissions are made every 2 hours for a 5-minute period on each frequency. During each transmission period, Morse-code keying gives atmospheric pressure at the floating level of the balloon and temperature inside the transmitter pack.

Later model equipment will include external temperature and humidity sensors. Provisions were made for two 30-second tones during each transmission period to aid in obtaining bearings.

The transmitters are of conventional design using crystal-controlled oscillators to drive a 6146 final amplifier through a buffer stage. Screen-grid keying is used on the final.

Frequency changing is accomplished automatically through a small d-c timing motor, actuated every 2 hours by an 8-day aircraft clock, which switches filament volt-

Inaccessible Areas

ages and antenna connections to the three separate transmitters. Information is coded by a modified dropsonde unit which serves as a keyer unit.

The antenna, as shown in Fig. 3, appears as an end-fed half-wave dipole for each frequency by employing wave-traps spaced and tuned to effectively terminate the antenna at an appropriate resonant length. The antenna feed system consists of a length of 450-ohm open-wire transmission line and an appropriate artificial line in each transmitter to effectively provide a quarter-wave transformer line section for each frequency. To reduce the input impedance of the antenna, ⅜ in. tinned copper braid is used as the radiating element.

Power Supply

Power for the transmitter is supplied by a series-parallel arrangement of sixty-eight BA-38 dry batteries which provide the 300-volt and 700-volt plate supply. Filament voltage is furnished by a 66-ampere-hour lead-acid storage battery at bottom of the gondola.

To minimize the effect of −40 C ambient temperatures, the battery compartment is insulated with Styrofoam.

The control shelf, in addition to providing altitude control of the balloon, performs the various required safety functions. A one hundred minute d-c timing motor in conjunction with a pressure switch provides a means of terminating the flight if the equipment does not clear 28,000-feet altitude within one hundred minutes after launching.

Termination is also provided should the equipment descend as much as 1,500 feet during the ascent period. At all times when the equipment is below 28,000 feet altitude, either ascending or descending, flashing red lights visible from all directions are provided. Each normal flight is terminated at a preset time by a primary timer or an auxiliary back-up timer generally set for a 4 to 6-day flight.

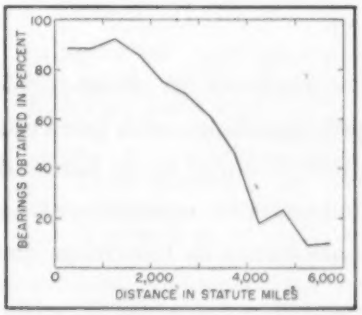


FIG. 2—Percentage of position fixes obtained in relation to distance of balloon from direction-finding stations

Upon termination of the flight the equipment gondola is released from the balloon and permitted to float to earth on a parachute, simultaneously the remaining iron-dust ballast is jettisoned, the flashing red lights are energized and the radio transmitters programmed to provide continuous data transmissions during the descent period.

Direction Finding

Direction finder fixes were obtained quite consistently to distances of 3,000 miles from the nearest direction-finder station. A statistical analysis of the data taken during periods in which quality rating for radiowave propagation varied from poor to good indicated that the probability of a station obtaining a usable bearing is approximately 88 percent out to a distance of 2,000 miles from the station. Over areas of similar propagation condition where six d-f finder stations are within 3,000 mile range the probability of obtaining a usable fix would be 0.94. With five d-f stations within 3,000 mile range, the fix probability would be 80 percent.

Gondola of weather balloon contains three transmitters at upper left with battery pack below. Top shelf contains timing equipment

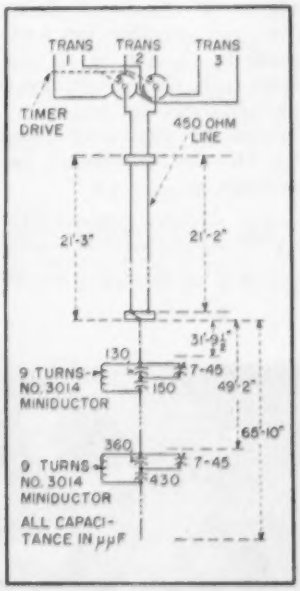


FIG. 3—Design of three-frequency transmitting antenna used in transosonde weather balloon

Video Amplifiers

By W. E. JEYNES
Chief Engineer
CHCH-TV
Hamilton, Ontario, Canada

SUMMARY —— Current feedback in shunt-regulated video amplifier circuits produces low output impedance with fair voltage gain; gain-bandwidth product of triode amplifier is equal to or better than that obtainable with high-slope pentodes. Characteristic equations of basic circuits are discussed along with practical applications in television distribution amplifiers

ALTHOUGH the shunt-regulated amplifier has been in use for some time in television modulator applications[1], it has not, until recently, been applied to video terminal equipment[2]. Two practical applications of this circuit are described in this article.

Basic Amplifier

In the basic shunt-regulated amplifier shown in Fig. 1A, current feedback[1,3] due to unbypassed resistor R increases the internal impedance of V_1 by a factor of $R(\mu_1 + 1)$ so that the load presented to V_2 is $r_{p1} + R(\mu_1 + 1)$ where r_{p1} is plate resistance and μ is amplification factor.

From the equivalent circuit of Fig. 1B, the open-circuit gain of the stage is

$$A_p = \frac{\mu_2[r_{p1} + R(\mu_1 + 1)]}{r_{p1} + r_{p2} + R(\mu_1 + 1)} \quad (1)$$

measured at the plate of V_2 and

$$A_k = \frac{\mu_2(r_{p1} + \mu_1 R)}{r_{p2} + r_{p1} + R(\mu_1 + 1)} \quad (2)$$

measured at the cathode of V_1.

The output impedance is

$$Z_o = \frac{r_{p1}(R + r_{p2})}{r_{p2} + r_{p1} + R(\mu_1 + 1)} \quad (3)$$

With suitable values of R, a fair voltage gain can be obtained into a reasonably low output impedance. The gain-bandwidth product is equal to or better than that obtainable by using a high-slope pentode. As R becomes infinitely large, Z_o will approach $r_{p1}R/(\mu_1 R) = 1/gm_1$ and the gain will approach $\mu_1\mu_2 R/(\mu_1 R) = \mu_2$.

In practice, it is not possible to obtain these limiting values of gain and output impedance. The advantage of using large values of R is not realized since the voltage drop across R limits the current through V_1 and V_2 resulting in rapid increases in the plate resistance.

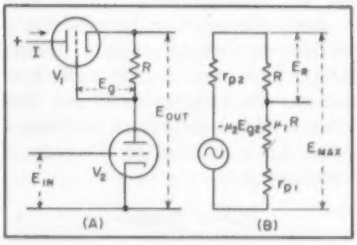


FIG. 1—Basic (A) and equivalent (B) circuits of shunt-regulated amplifier

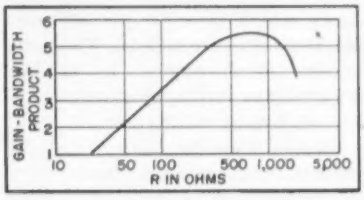
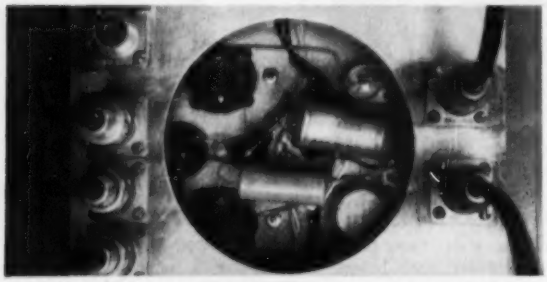


FIG. 2—Gain-bandwidth characteristic

The gain-bandwidth characteristic of the circuit of Fig. 1A, using both sections of a 6BK7A and



Rear chassis view of tv distribution amplifier shown in Fig. 5

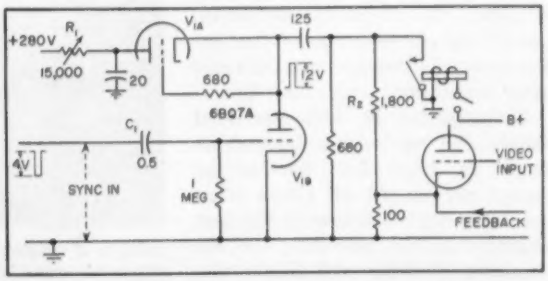


FIG. 3—Sync amplifier feeds cathode of video amplifier

Use Shunt Regulation

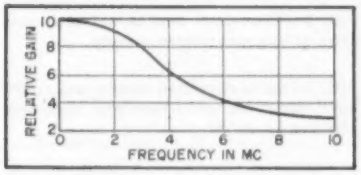


FIG. 4—Response of amplifier of Fig. 3 is adequate for sync transmission

loaded with a high impedance, is shown in Fig. 2. There is not much to be gained by increasing R beyond 500 ohms.

With identical triodes, experiment has shown that the optimum value of R is approximately 10 percent of r_p. The equations for gain and output impedance then simplify to

$$A = \mu(1 + 0.1\mu)/(2.1 + 0.1\mu) \quad (4)$$

$$Z_o = 1.1r_p/(2.1 + 0.1\mu) \quad (5)$$

Practical Circuit

Figure 3 shows a circuit, employing the shunt-regulated amplifier, now in use at CHCH-TV.

The gain at the cathode of V_{1A} is approximately three; the gain-bandwidth characteristic is shown in Fig. 4. This is more than adequate for the transmission of synchronizing signals.

With the cathode of V_{1B} connected to ground, there is a 155-v d-c drop across V_{1A}. The d-c current through V_{1A} and V_{1B} is approximately 4.5 ma. With this connection, plate limiting occurs at around 3-v signal input.

For a square-pulse voltage, this has the effect of limiting the output, while preserving the waveshape. Advantage is taken of this fact to provide an automatic amplitude control of the synchronizing signal, provided that the input does not fall below 3 v. This takes care of normal variations in the output of the synchronizing-signal generator.

Operation

In operation, R_1 is adjusted for 0.4 v of synchronizing signal at the output of the video amplifier.

With plate limiting, a change in the d-c supply voltage changes the amplitude of the signal voltage. However, with the use of a well-regulated d-c power supply, this effect is not of any consequence.

In Fig. 3, the cathode resistor of the video amplifier tube is a low tap on the load resistance of the synchronizing signal amplifier and it is possible to change the d-c supply voltage ±5 v without noticably affecting the signal at the output of the amplifier.

Actually about 1/18th of the voltage developed at the cathode of V_{1A} is injected at this tap point.

This means that the negative side of C_1 can be shorted to ground for sync suppression when the amplifier is passing composite picture signals.

The impedance in the cathode of V_{1A} is not materially affected when it is shunted by R_2, so the gain-bandwidth characteristic of the video amplifier is not affected. The shorting relay also suppresses the large positive-going pulse which would normally be present at the cathode of V_{1A} which might tend to introduce pulse crosstalk when handling remote composite signals.

Distribution Amplifier

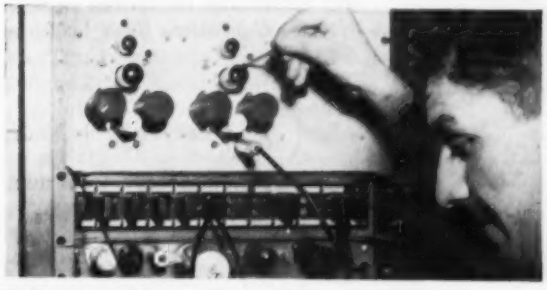
A studio distribution amplifier employing two shunt-regulated stages is shown in schematic form in Fig. 5.

The amplifier's response is flat to 10 mc at unity gain, with three outputs, each into 75 ohms. One output terminated in 75 ohms gives maximum gain of 3.3. Maximum picture input voltage is 2.5 v peak to peak.

Peak-to-peak pulses of 4 v may be handled. The slight amplitude distortion which results can be compensated for by an adjustment of the gain control, with some slight reduction in bandwidth.

References

(1) V. J. Cooper, Shunt Regulated Amplifiers, *Wireless Engineer*, May 1951.
(2) John O. Schroeder, Studio Amplifier Design for Color Television, ELECTRONICS, Mar. 1955.



Maintenance engineer adjusts rack-mounted amplifier

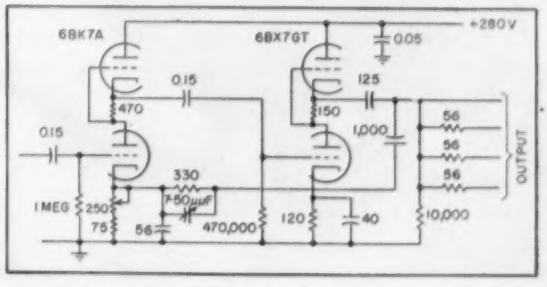


FIG. 5—Video distribution amplifier uses two cascaded stages

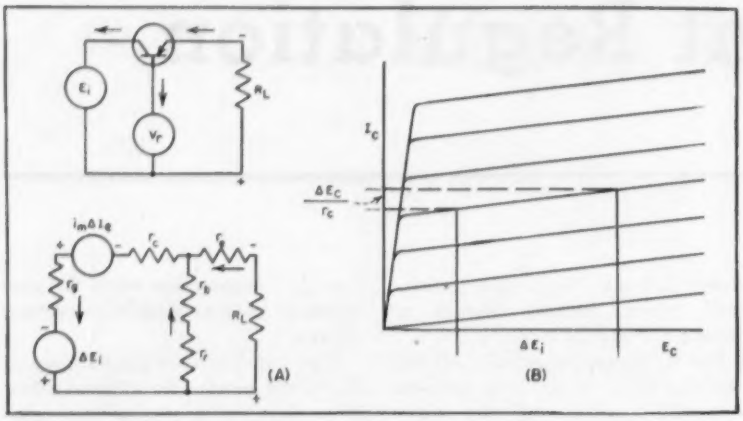


FIG. 1—Series-regulated supply and equivalent circuit (A) using transistor characteristic shown at (B)

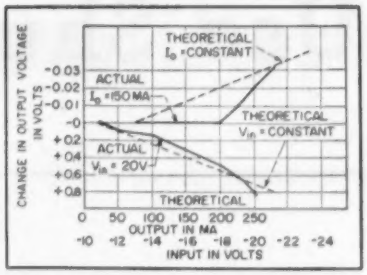
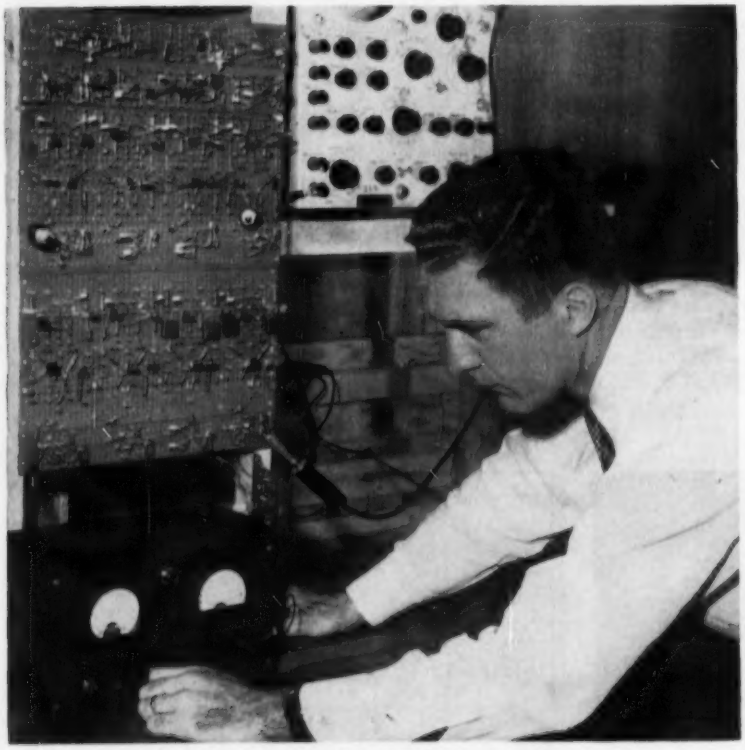


FIG. 2—Theoretical and actual characteristics of series-regulated supply

Regulated Transistor

SUMMARY —— Series and shunt regulator design equations provide method of obtaining low voltage power supplies with any required degree of regulation. Actual circuit derived from these equations are discussed and laboratory tests show good agreement with predicted operation



Experimental supplies use terminal board construction for ease of measurement

SIMPLE compact low-voltage transistor power supplies are now entirely feasible using available transistors. Virtually any degree of regulation can be obtained with only a small increase in complexity of the circuit.

The output voltage of a power supply is a function of output current and input voltage

$$E_o = E_o(E_i, I_o) \qquad (1)$$

E_o = output voltage, E_i = input or line voltage, I_o = output or load current. Since in actual practice the load is established by the choice of load resistance, or more conveniently load conductance the output voltage can be written as $E_o = E_o(E_i, G_L)$ where G_L is load conductance.

Then

$$\Delta E_o = \left(\frac{\Delta E_o}{\Delta E_i}\right)_{\Delta G_L = 0} \Delta E_i + \left(\frac{\Delta E_o}{\Delta G_L}\right)_{\Delta E_i = 0} \Delta G_L$$

Multiplying the second term numerator and denominator by $E_o + \Delta E_o$:

$$\Delta E_o = \left(\frac{\Delta E_o}{\Delta E_i}\right)_{\Delta G_L = 0} \Delta E_i +$$

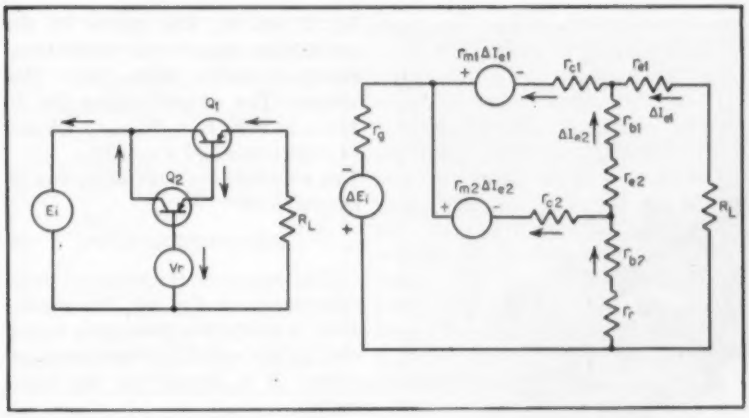


FIG. 3—Two transistor regulator characteristics are determined by equivalent circuit as described in text

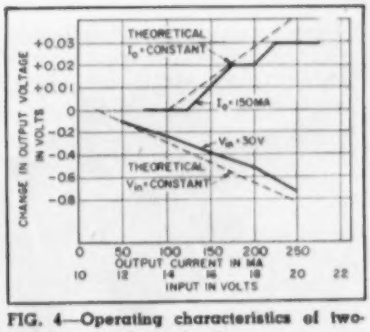


FIG. 4—Operating characteristics of two-transistor regulator circuit

Power Supply Design

By J. WALTER KELLER, Jr.*

Project Engineer
Diamond Ordnance Fuze Laboratories
Washington, D. C.

$$\left(\frac{\Delta E_i}{(E_o+\Delta E_o)\Delta G_L}\right)_{\Delta E_i=0}(E_o+\Delta E_o)\Delta G_L$$

$(E_o + \Delta E_o)\ \Delta G_L$ differs from ΔI_o by the term $G_L\Delta E_o$. This term can be neglected because, with any reasonable regulator, it is quite small compared to ΔI_o. Thus

$$\Delta E_o=\left(\frac{\Delta E_o}{\Delta E_i}\right)_{R_L=\text{constant}}\Delta E_i+\left(\frac{\Delta E_o}{\Delta I_o}\right)_{\Delta E_i=0}\Delta I_o \quad (2)$$

This equation justifies the experimental procedure of holding R_L constant instead of I_o when obtaining the voltage regulation.

This equation is the basis for the a-c type of equivalent circuit. The output voltage variation is equal to the input voltage minus an I-R voltage drop. The two terms on the right of Eq. 2 should be as small as possible. Consequently the design of a voltage regulator should concentrate on making $\Delta E_o/\Delta E_i$ and $\Delta E_o/I_o$ as small as possible.

The most simple regulator design attempted is shown in Fig. 1A.

The transistor is a *pnp* power unit rated at 20 watts, with a heat sink at 25 C. The emitter of the transistor is biased in the forward direction and tends to be very close to the potential of the base which is the reference voltage. Line-voltage variations are dropped across the large dynamic collector resistance and are greatly reduced at the emitter.

To determine the coefficients of Eq. 1 assume linear operation and from small-signal equivalent circuit theory

$$\left(\frac{\Delta E_o}{\Delta I_o}\right)_{\Delta E_i=0}=-r_o-(1-\alpha)(r_b+r_r) \quad (3)$$

This is the load regulation of the circuit of Fig. 1A. The input-voltage regulation employing small-signal equivalent circuit theory is

$$\left(\frac{\Delta E_o}{\Delta E_i}\right)_{\Delta E_i=0}=\frac{r_b+r_r}{r_e\left[1+\frac{(1-\alpha)(r_b+r_r)}{R_L+r_e}\right]}\times\frac{R_L}{R_L+r_e} \quad (4)$$

This assumes $r_e >> r_b + r_r + r_g$, and R_L = load resistance.

The operation of input voltage regulation can be seen by observing that the slope of the collector characteristics, shown in Fig. 1B, is approximately the series resistance to input voltage changes.

Now Eq. 2 becomes

$$\Delta E_o=\frac{r_b+r_r}{r_e\left[1+\frac{(1-\alpha)(r_b+r_r)}{R_L+r_e}\right]}\times\frac{R_L}{R_L+r_e}\Delta E_i-[r_e+(1-\alpha)(r_b+r_r)]\Delta I_o \quad (5)$$

For a power transistor, substituting typical parameter values r_e = 10K, r_r = 1.5, r_b = 50 and α = 0.96, R_L = 75, r_r = 0, in Eq. 5 the following equation is obtained:

$$\Delta E_o=0.004\Delta E_i-3.5\Delta I_o \quad (6)$$

Using the circuit shown in Fig. 1A the curves of Fig. 2 were obtained. The nonlinearity of the experimental points and their departure from the theoretical value were expected in view of the large variation of transistor parameters with operating point. However, this does not limit the utility of the regulation equations in most practical cases because power supplies are usually employed in a narrow range making the assumption of a

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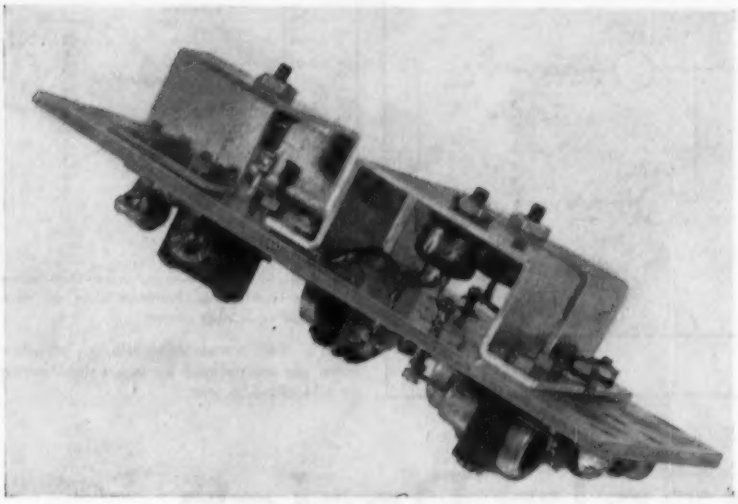


Regulated power supply uses metal bracket construction as heat sink for power transistors. Rectifiers are mounted on underside of board

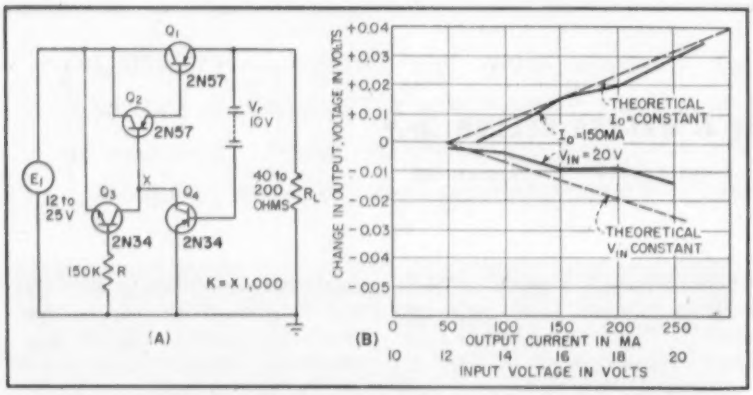


FIG. 5—Regulator using four transistors including a single-stage feedback amplifier (A) shows good correlation between actual and theoretical results (B)

single operating point a good approximation.

Equation 5 appears to contain sufficiently accurate relationships upon which further design considerations can be based. It can be predicted that better regulation would result from a higher alpha and r_c or lower r_b, r_e and/or r_r.

One major drawback of the circuit of Fig. 1A is that it draws too much reference current. The circuit of Fig. 3 gives about the same regulation, but with substantially less reference current drain. Since $I_r = (1 - \alpha) I_e$, the reference current assuming identical transistors is approximately $0.002 I_e$. This is equivalent to having a larger α.

Employing the equivalent circuit of Fig. 3 regulation will then be:

$$\frac{\Delta E_o}{\Delta I_o} = -[r_{e1} + (1-\alpha_1)(r_{b1} + r_{e1}) + (1-\alpha_1)(1-\alpha_2)(r_{b2} + r_r)] \quad (7)$$

$$\frac{\Delta E_o}{\Delta E_i} = \frac{\dfrac{r_{b1} + r_{e1} + (1-\alpha_2)(r_{b2} + r_r)}{r_{e1}} \dfrac{r_{b2} + r_r}{r_{e2}}}{1 + \dfrac{(1-\alpha_1)}{R_L + r_{e1}}[r_{b1} + r_{e1} + (1-\alpha_2)(r_{b2} + r_r)]} \times \frac{R_L}{R_L + r_{e1}} \quad (8)$$

These equations show that the reference resistance can be much larger than in the single transistor circuit before it becomes significant. Since Q_1 will be carrying the full-load current and since the circuit will be required to deliver currents close to the peak ratings of Q_1 the alpha and r_e of this transistor may be much smaller than for small-current bias. It would not be wise to assume equal parameters for the two transistors when using Eq. 7 and 8. The values of the parameters used in the single-transistor regulator were large bias values. The proper values for Q_1 are $r_e = 90K$, $r_b = 60$, $r_c = 2.5$ and $r_r = 50$ ohms and $\alpha = 0.97$.

The equation for regulation can be shown to be

$$\Delta E_o = 0.0067 E_i - 3.7 \Delta I_o \quad (9)$$

This equation is compared with experiment in Fig. 4. The agreement is good since parameter values used in the equations were average values of a sample of ten transistors.

Both circuits discussed are basic series-type regulators employing the collector resistance for dropping line voltage to output voltage. The size of the dropping resistor is dependent upon the difference in voltage between the load and the base, or reference, less the drop in voltage caused by current in the emitter, base and reference resistances. The regulation is a function of the I-R drop in the circuit path between output voltage and reference. This drop can be made small by making the resistance of this path small or by making the change in current small in this circuit. Clearly, the size of the reference current change is dependent upon the amplification in the loop that tries to correct for output voltage changes.

When a single transistor is used to sense the difference in reference voltage and output voltage, regulation can be expressed as

$$\frac{\Delta E_o}{\Delta I_o} = \frac{\left[\dfrac{r_{sf}}{1-\alpha_f} + r_{bf} + r_r\right]}{G_m} \quad (10)$$

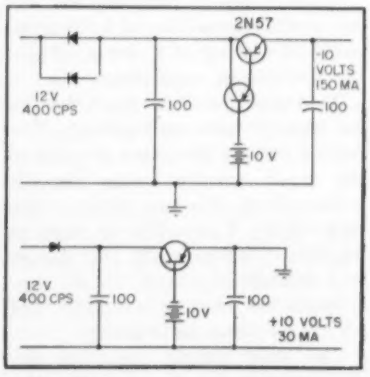


FIG. 6—Power supplies providing plus and minus 10 volts designed for use in ordnance field equipment

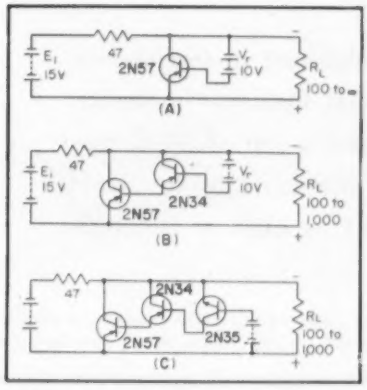


FIG. 7—Three shunt-type transistor regulators for low-voltage power supplies

$$\frac{\Delta E_o}{\Delta E_i} = \frac{\left[\frac{r_{cf}}{1-\alpha_f} + r_{bf} + r_r\right]}{G_o R} \qquad (11)$$

where the subscript f, refers to the transistor parameter of the first amplifying stage, or the stage where the reference is compared with the output voltage. The G_o, is total current gain in both the control and series resistance sections of the power supply and R is the total parallel resistance between the input voltage line and the junction of the series resistance and control sections.

Figure 5A shows an example of a voltage regulator employing a single-stage feedback amplifier. The dynamic series dropping resistor is made up of Q_1 and Q_2. Transistor Q_4 provides stage of gain. Transistor Q_3 supplies a constant current to junction X which is shared by the base of Q_3 and collector of Q_4.

If the output voltage decreases as the result of a greater load current the base voltage of Q_4 will decrease toward ground causing Q_4 to conduct less. The current that normally would have gone through Q_4 now is diverted through Q_3. This causes both Q_3 and Q_1 to conduct more, which is equivalent to reducing the series-regulator resistance and results in the output voltage increasing, thus tending to compensate for the drop in voltage.

Transistor Q_3 should be connected backwards, using the emitter as collector. Temperature stability of a transistor with large resistance in the base is poor unless the alpha is low. The alpha is usually quite low in the back direction. Furthermore, the quality of this particular connection as a constant current source is independent of alpha.

Under certain conditions, better regulation could be obtained by employing transistor Q_3 as an additional gain stage in the amplifier and using a resistor in the input voltage line to the base of Q_3 to supply the needed current. This would depend mainly on how much larger the input voltage is as compaired to the output voltage and the required regulation range.

The equation for regulation is

$$\Delta E_o = \frac{r_{c4} + (1-\alpha_4)(r_{b4}+r_r)}{\alpha_4 R \frac{1-\alpha_3}{\alpha_3}} \Delta E_i - \frac{(1-\alpha_1)(1-\alpha_3)}{\alpha_3 \alpha_4} \times [r_{c4} + (1-\alpha_4)(r_{b4}+r_r)]\Delta I_o \qquad (12)$$

A solution to Eq. 12 using typical transistor parameters gives $\Delta E_o =$ $0.004\ E_i - 0.13\Delta I_o$. The comparison of this equation with experiment is shown in Fig. 5B.

Supplies giving outputs of +10v and −10v are shown in Fig. 6.

Temperature

The single transistor regulator of Fig. 1A has a 2.5-percent change in output voltage over the temperature range of 25 C to 80 C. The circuit of Fig. 3 has a 5-percent change in output voltage over that range. This temperature coefficient can be compensated by employing a reference with a negative temperature coefficient.

In more complicated regulators employing high-gain servo amplifiers the major temperature problems are found in the amplifier, and principally, in the first stage where the comparison between reference and output voltage is made. Silicon components employed here may alleviate the problem but there will still be a need for compensation of the emitter to base voltage change in the first or comparison stage.

Shunt Types

The shunt types of power supply shown in Fig. 7 are subject to the same general type of analysis as the series units. While their regulation in a limited range can be made as good as the series type, the total range over which they will regulate is in general less. Over a small range the circuit of Fig. 7C has desirable features. It is simple, its voltage reference is grounded on one side which lends itself to use of Zener diodes and its regulation is comparable to the best 3-transistor series-type regulator.

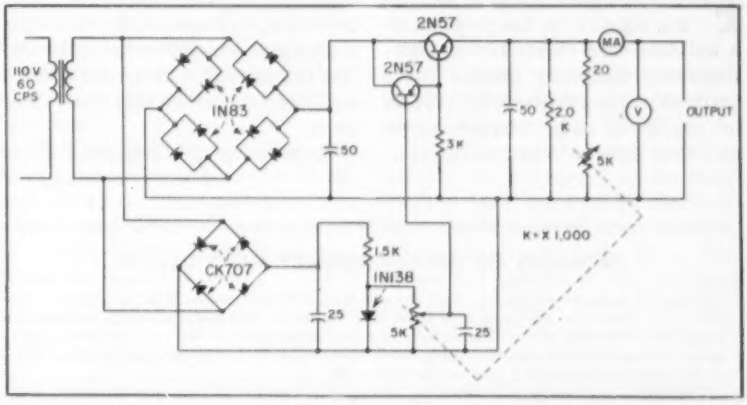


FIG. 8—Variable voltage regulated supply for laboratory use employs two transistors

A variable voltage regulated power supply for laboratory use is shown in Fig. 8. Note that there is no feedback stage. One additional transistor feeding back from the reference could improve the regulation by a factor nearly equal to the beta of the added transistor.

Thanks are extended Stanley Gordon who experimentally checked the formulas, Charles Durieu for recommendations of mathematical rigor and Morris Brenner for supplying transistor parameters.

SUMMARY — Sharply defined transducer gap is obtained in ferrite-core head by using 0.002-in. metallic pole shoes of special magnetic material. Silicon monoxide deposited on the pole faces provides a gap of 20 microinches. Design makes possible pulse recording at densities up to 2,500 pulses per inch with playback-voltage output almost as high as for 100-pulse per inch recording made with same head

By OTTO KORNEI*

Head, Transducer Development
Clevite Research Center
Clevite Corp.
Cleveland, Ohio

MAGNETIC HEAD

FERRITES appear to be a promising solution to the problem of a suitable core material for high-frequency recording heads. Their extremely low conductivity results in negligible eddy current losses and they have a substantially constant permeability into the megacycle range. However, ferrites have a granular and brittle texture making it impossible to prepare short, well defined and durable transducer gaps.

To combine the low-loss feature of ferrites with the excellent gap definition of metal, ferrite cores were provided with metallic pole shoes in the construction of a new type of magnetic head. Simple as this approach appears to be, it creates a number of special problems.

It is important to keep eddy current losses in the pole shoes to a minimum so as not to nullify the advantages of the ferrite cores. This can be accomplished by using thin pole shoes fabricated of a magnetic material with high electrical resistivity. First experimental models of such modified ferrite heads developed pole-shoe losses high enough to scorch the tape during the recording process. These heads were equipped with relatively thick metallic Permalloy pole shoes.

Shunt magnetic flux across the faces of the pole shoes must be as low as possible. In view of the small gap lengths, this calls for extremely thin metal shoes. This also favors reduction of eddy current losses in the pole shoes.

Another requirement is high wear resistance. This point is important because of the necessary thinness of the pole shoes and the high tape speed.

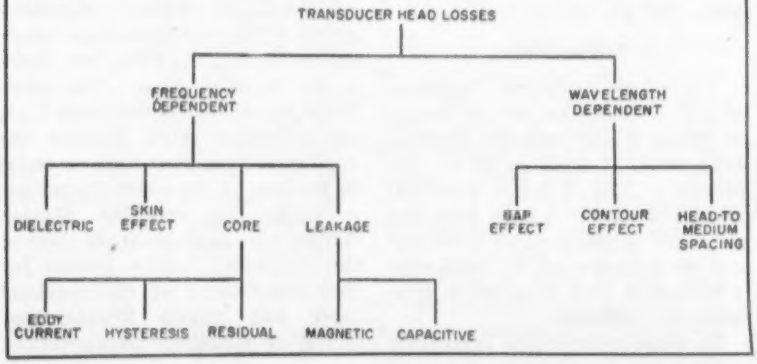
At the time of the development

PROBLEMS OF HIGH-FREQUENCY HEAD DESIGN

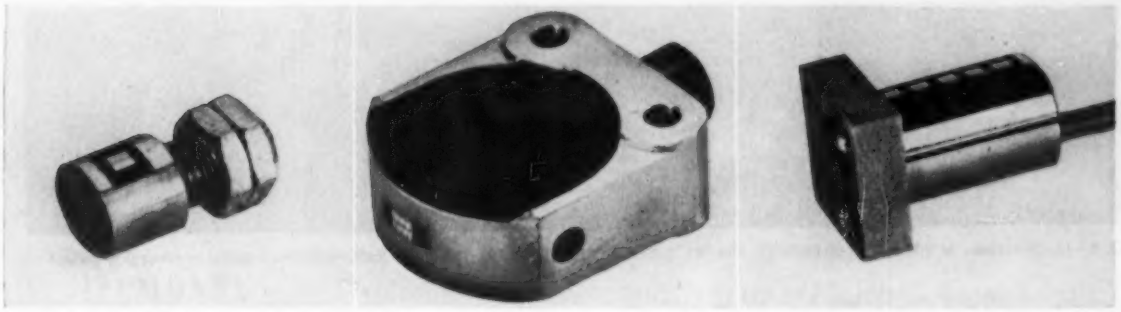
Design of magnetic transducer heads for recording and reproducing high frequencies presents two independent problems: total losses must be low to yield useful playback voltages at reasonable recording power requirements and resolution must be high to permit practical speeds of the recording medium. Some heads now in use come close to meeting either one of the requirements but not both at the same time.

Total losses incurred in both recording and playback consist of frequency-dependent and wavelength-dependent components. The latter are not actual power losses but they do contribute to a reduction of playback level. Eddy current losses and the gap effect losses have great practical importance and their simultaneous reduction within the same structure poses substantial problems.

Subdividing the metallic core into thin laminations to reduce eddy currents finds practical limitations in the megacycle range. Thin laminations are not only difficult to handle but they also preclude formation of straight edges necessary for a short transducer gap. These drawbacks become particularly apparent since cores for the megacycle range should be composed of laminations not thicker than about 0.001 inch.



* Now with IBM Research Laboratory Poughkeepsie, N. Y.



Megacycle recording heads using ferrite cores are, left to right, miniature and standard-size single-channel heads, and a multiple-head minature unit. The miniature units are about ⅜ in. in diameter

Has Megacycle Range

of the high-frequency head a new magnetic alloy became experimentally available which had all the qualifications desired for the pole shoe material. This new alloy, 16-Alfenol, has magnetic properties approaching those of soft magnetic materials, combined with much higher electrical resistivity and with a many times increased abrasion resistance.

Head Construction

The optimum thickness of the metal pole shoes has been determined to be about 0.002 inch. Thicker pole shoes cause excessive losses from eddy currents and from flux shunting. Thinner shoes give too high magnetic reluctance and are undesirable because of reduced head life.

The ratio between optimum gap length and optimum pole-shoe thickness thus becomes about 1 to 100. This is nearly the same value used in many high-quality magnetic heads for the audio range.

Gap Design

The gap is given a small but well defined magnitude by vacuum depositing a suitable spacer material onto the faces of the pole shoes. Tests have shown that there is a definite limit to the improvement in resolution which can be obtained by reducing the gap length

Below a certain magnitude no further improvement takes place but the playback voltage starts to decrease because of the relatively increasing effect of the shunt flux across the gap faces. The shortest useful gap length has been experimentally determined to be approximately 20 microinches.

The reason for the ultimate lim-

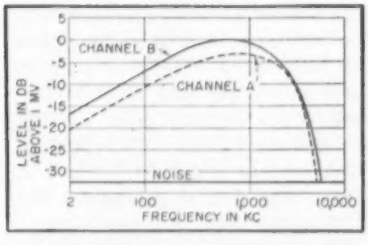


FIG. 2—Frequency response of two-channel head with 8-ma recording current in both heads

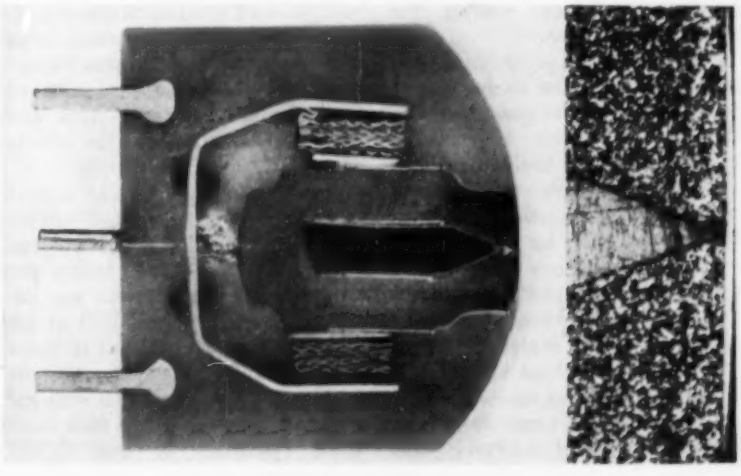


FIG. 1—Cross section of experimental recording head with photomicrograph of gap area showing pole shoes and gap spacer

FIG. 3—Oscillograms of playback of 100 (A), 500 (B), 1,000 (C) and 2,000 (D) pulse per inch recordings using rectangular pulses

itation of the resolution appears to lie in the always imperfect contact between head and tape surface. Even the best commercial tapes show a surface roughness of 15 to 20 microinches which, effectively, accounts for a tape-to-head spacing of the same magnitude.

Playback loss caused by such spacing, expressed in decibels, equals fifty-five times the ratio of spacing to wavelength. In view of these facts, no increase of head resolution can be expected from reducing gap length below approximately 20 microinches. Any further improvement of the head resolution will have to be preceded by improved recording tapes.

Spacer Material

Of the materials investigated for use as a gap spacer, silicon monoxide was finally chosen. This material is quite hard and therefore helps to maintain a sharply defined transducer gap. It is a nonconductor eliminating eddy-current losses. It can be readily evaporated in vacuum and it is sufficiently transparent to permit an accurate thickness control by observation of interference fringes during the evaporating process.

Figure 1 shows a cross section through one of the early experimental heads of the described construction. The two symmetrical ferrite pieces with their metal pole shoes and single-layer windings can be seen. These two core halves are clamped together by a U-shaped metal spring and are embedded in casting resin. A photomicrograph of a cross section through the gap region of the head is also shown.

The metal pole shoes appear as a light-colored overlay on the tips of the ferrite pole pieces. The tight joint between metal and ferrite can also be seen. This is necessary to keep magnetic reluctance to a minimum.

Performance Tests

The performance of the high-frequency heads was determined with commercial recording tapes. Some variations were observed between tapes of different manufacturers and between different lots from the same manufacturer. Such variations were most pronounced at the shorter wavelengths. The short-wavelength response also varied with the wear condition of the tape. The response improved as the tape surface became glazed by wear, then staying substantially constant until the beginning of final tape deterioration.

All data given here were obtained in a closed loop tester, after an initial run-in period of the tape. Under the chosen operation conditions it took several hundred passes of the tape to stabilize it. The same head was used for recording and playback to avoid azimuth error.

Tests of this type require the best possible contact between tape and head and great care must be used in the fine adjustment of their mutual positioning. A small wrap angle has been found to be important to prevent the formation of an air cushion between tape and head and to minimize the effects of tape stiffness and inertia.

Figure 2 shows typical output versus frequency-response curves obtained from a two-channel head at a tape speed of 240 inches per second. Recording current was adjusted for maximum output at 2.5 to 3 mc. No bias was used in these tests. It can be seen that a highest frequency of over 4 mc is still reproduced, corresponding to a maximum resolution of over 17,000 cycles per linear inch.

Whenever proportionality between the playback voltage and the recording current is required either d-c or a-c bias must be used. Such bias degrades high-frequency response. The extent of this effect can be approximated by a displacement of the show response curves to the left by about 25 percent of the frequency readings.

Head Life

Because of still insufficient data, total operating life of the heads can only be estimated at this time. Based on the results of various tests it appears to be on the order of over 100 hours at a tape speed of 240 inches per second and substantially more at lower speeds.

The high resolution and the low losses of the new head are also prerequisites for effective handling of pulse information. Figure 3 illustrates some preliminary results of tests in that direction. The recordings were made in a return-to-zero scheme, using rectangular pulses of 1-microsecond duration and a tape speed of 60 inches per second. At a density of 2,000 pulses per inch almost the same playback voltage can be obtained as at 100 pulses per inch and a density as high as 2,500 pulses per inch is quite feasible. Such extreme pulse packing and correspondingly high repetition rates may be too high for use in present-day digital equipment but demonstrate future possibilities.

The material in this article was presented in a paper before the 1956 IRE Convention. The work benefitted substantially from the skill of H. J. Mueller who was in charge of the mechanical aspects of the project and H. J. Morgan who performed the electrical measurements on the heads.

SUBCARRIER SWITCH for Microwave Party Line

SUMMARY —— Electronic switch, actuated by voice modulation, keeps local subcarrier oscillators of party-line voice channel off the air until one of the local transmitters receives an input. Audio received at input terminals modulates the channel transmitter while a portion of the input is rectified to override cut-off bias on final amplifier screen grid. Rectified audio from channel receiver restores cut-off bias to insure that only the station having the strongest input will gets its subcarrier on the air

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TO OBTAIN PARTY-LINE communication in a transmission system, it is necessary to establish a voice channel having a number of parallel terminals located at various stations. In designing Westinghouse FJ multiplex equipment to operate with FR microwave radio, frequency-division multiplexing was selected.

To keep the design and maintenance as simple as possible and prevent frequency translation, amplitude-modulation equipment was chosen. This introduced the problem on party-line circuits that if carrier frequencies originating at different stations were not exactly the same, beat notes or heterodyne whistles would be heard at each voice terminal on the party line.

Avoiding Interference

This interference has been avoided in some applications by single-sideband multiplex since the carrier is suppressed and one of the sidebands is filtered out. The remaining sideband will not create heterodyne interference when mixed with other similar signals in the carrier receivers. At each receiver it is necessary to reinsert a carrier close to the frequency of the original carrier in order to recover the intelligence carried by the one sideband.

The single-sideband system was felt to be relatively complicated in the 300 to 600-kc frequency range chosen for the multiplex owing to the relatively narrow-band and sharp-cutoff characteristics required in the filters to reject the undesired sideband. Another serious objection was the difficulty in keeping the frequency of the reinserted carrier at the receiver the

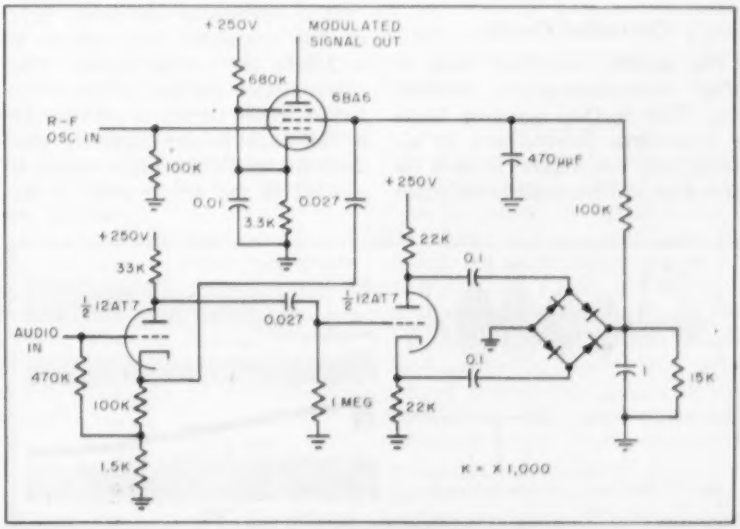

FIG. 1—Final amplifier of local channel transmitter showing screen-grid modulator and bridge rectifier for developing positive bias

same as the original carrier frequency which was suppressed at the transmitter.

If these two frequencies are not nearly identical, the system can not be used for frequency sensitive schemes such as frequency-shift, frequency-telemetering or high-fidelity signals. Also, if the two frequencies drift far enough apart, even regular speech signals become sufficiently translated in frequency range to become unintelligible.

Push-to-Talk System

Another scheme used for multi-station communication on a party-line basis uses double sideband a-m or f-m with transmitters normally shut down. A transmitter is switched on by a voice-actuated device or by a manually operated pushbutton. There are a number of deficiencies which limit the applications of these schemes, the most important being clipping of the initial intelligence in the voice-controlled scheme.

In the push-to-talk scheme, the inconvenience and also the inability to interrupt a remote speaker represent serious drawbacks in common telephone practice. Furthermore, these schemes cannot be applied easily to two-wire lines which must go through switchboards, dial equipment or similar telephone apparatus.

Controlled Carrier

The scheme described here is called controlled-carrier modulation. This method prevents beats or heterodyne interference by allowing only one station to have its carrier on and transmit intelligence at any one time. The circuit is such that when one person is talking, the transmitters at the other stations are normally kept disabled.

This is accomplished by cutting off the multiplex carrier of the channel transmitter when the level or amplitude of the received audio signal in that channel is greater than the level of the audio signal which is intended to be transmitted from that station. The only station in a channel which can transmit at any one time is the one having the greatest audio output level. Anyone in the channel listening to this audio signal may interrupt the remote party who is talking by raising the level of his speech above that of the received signal.

Actually, the level of the incoming speech varies over a wide range of amplitudes in a fraction of a second so that the remote party can be made aware of an interruption by the listening party even without his raising his speech level.

Circuit Description

Operation of this system is shown in Fig. 1. The screen grid of the 6BA6 modulator is set at a slightly negative potential with respect to the cathode, rendering the tube nonconducting. When audio is applied to the input terminals, it is amplified and divided into two different circuits.

It is applied to the screen grid of the modulator and serves to modulate the carrier signal. The other circuit includes a phase inverter whose output is rectified by a full-wave bridge rectifier, producing a positive voltage which is applied to the screen grid of the modulator to render it conducting.

Thus, carrier is produced only when an audio signal is present. The d-c developed on the screen grid is directly proportional to the amplitude of the audio signal applied. Therefore, the audio and d-c which are always in a fixed ratio, resulting in a constant percent modulation. This is illustrated in Fig. 2A.

This system will give the advantage that regardless of the amount of audio signal present, a constant percentage of modulation is maintained. It is impossible to produce distortion by overmodulating the carrier.

Rise and Decay Times

The resistor and capacitor across the d-c output of the bridge rectifier filter the rectified audio voltage and provide a time constant for regulating the amount of time the carrier remains on after the audio signal is removed. Figure 2B shows the rise and decay time of the system as measured on the d-c output of the receiver detector. The rise time is 3 milliseconds for the 1,000-cps tone to reach 63 percent of its final value. The decay time, which is the time required for the carrier to reduce to near zero, is shown by the d-c fall-off on the receiver detector and is approximately 250 milliseconds.

The timing traces were 1,000 and 200 cps for the rise and decay times respectively. The rise time is fast to avoid clipping the beginnings of speech. The decay time is relatively long to avoid clipping the final syllables or thumping as the carrier cuts off.

Voice Panel

Figure 3 is a block diagram of the voice-band panel, showing sending, receiving and signaling circuits. A common circuit between the receiver and transmitter called the compensating network insures that the transmitter does not normally allow energy to be transmitted while the receiver is receiving a signal. This is important when the phones of several stations on the party line are off the hook. Other-

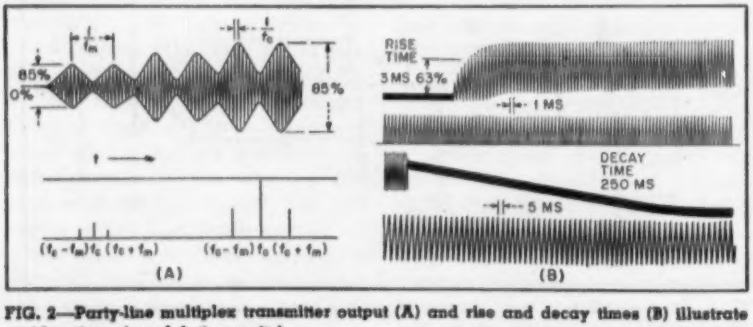

FIG. 2—Party-line multiplex transmitter output (A) and rise and decay times (B) illustrate rapid action of modulation switch

wise, ordinary room noise would cause the transmitters at these stations to operate and send out energy.

Thus the collective room noise would appear in all receivers, requiring the person who is talking to speak at an increased level to be heard. This condition is avoided by the compensating network and allows a number of stations to be operated on a party line basis without excessive room-noise interference.

To allow the transmitter to emit energy, a positive direct voltage must be applied to the screen grid of the modulator. Therefore, if a negative voltage were applied simultaneously and of correct amplitude, the transmitter would remain completely cut off. The detector employed with the receiver is arranged to produce a d-c component which is negative with respect to ground.

When this voltage is filtered and applied to the screen grid of the modulator, it holds the modulator tube cut off for the time that a received signal is present. The conversation may be interrupted during slight speech pauses or by over talking the blocking voltage.

Audio Leaks

The system provides a d-c holding or compensating voltage proportional to the level of the incoming received signal. This is desirable since it can be arranged to compensate for the received audio signal that leaks through the hybrid coil and gets into the transmitter input circuits.

This leak results from the difficulty in obtaining sufficiently good balance of the hybrid circuits when used with the widely varying impedance of many two-wire telephone lines interconnected with radio or carrier systems.

The signal that leaks through the hybrid circuit and enters the transmitter input circuit is not intended to modulate it. It can be as large or larger in amplitude than the signal received from the telephone line that is intended to modulate the transmitter. This results in a system in which the signal as received from the microwave circuit may be transmitted back to its origin as well as into the telephone line it is intended to reach.

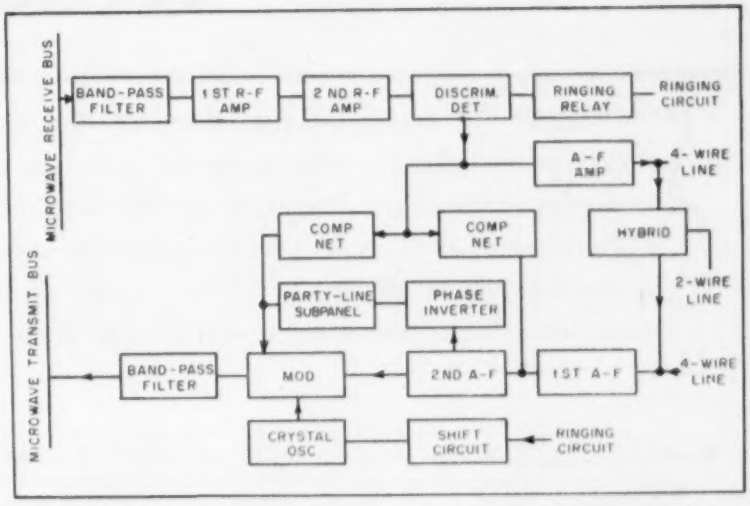

FIG. 3—Voice-band panel for party-line channel of microwave multiplex communications system insures that only local station having strongest audio input can get its subcarrier oscillator on the air

In party-line systems involving many transmitters and receivers this results in putting several transmitters into simultaneous operation and modulating them. Emission of these signals into the common transmission system could result in an echoing or chaotic and unintelligible condition of interfering signals.

The compensating circuit uses the d-c output of the receiving detector to prevent the modulation of its transmitter carrier. When receiving a signal, the transmitter is blocked preventing such chaotic conditions. The need for a special balance network for the hybrid is thus reduced.

If a slight unbalance were to occur, the received signal would not be retransmitted. Only a resistive balance network is usually required. Thus a greater effective hybrid balance is achieved than could be attained by any ordinary method.

Advantages

The proportional carrier system realizes many of the advantages of a single sideband system including a substantial improvement in signal-to-noise performance over the microwave system. With no modulation on a channel, little or no carrier is present from that channel to modulate the radio. Accordingly, the composite signal produced by a number of proportional carrier voice channels is lower, and the level of each channel may be raised without overmodulating the radio modulator.

The higher modulation level per channel gives an improved channel signal-to-noise ratio. The absence or reduction of background noise between speech passages also gives an apparent improvement in performance.

Applications

In private-line applications where suppressed-carrier operation is desired, the party-line circuit is used. The carrier is suppressed about 20 db and the performance cannot be distinguished from conventional wire-line equipment.

In party-line applications where the carrier is completely suppressed during the periods of no modulation, the only noticeable difference is the quiet background between voice passages similar to companders. In either case normal conversation can be carried on with either party able to interrupt the other when desired.

THREE NEW

SUMMARY —— Temperature-stabilized flip-flop, tone keyer and audio-frequency meter using junction transistors make use of favorable large-signal properties of transistors. The flip-flop achieves temperature stability through diode switching in the emitter circuits. The tone keyer switches tones ranging in frequency from 100 cps to 200 kc at rates up to 10 kc. The frequency meter uses silicon transistors to achieve operation up to 100 C

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LARGE-SIGNAL OPERATION of junction transistors results in many useful and interesting circuits.

Improved high-temperature operation of a junction transistor flip-flop is achieved with diode switching in the emitter circuits. Stability factor is improved from 20 or more to about 2 or 3. Operation up to 70 C is obtained using transistors rated for 50 C.

Also stable against temperature variation is a tone keyer that controls tone frequencies from 100 cps to 200 kc at keying speeds up to 10 kc. Keying may be by a d-c signal or by contacts. Supply voltages from 6 to 35 v can be used.

A frequency meter employing silicon transistors withstands temperatures up to 100 C. The meter is designed for audio frequencies. It has a substantially linear frequency scale. There is no zero offset.

Stabilized Flip-Flop

A limiting factor in the use of germanium junction transistors is collector saturation current I_{co}. The saturation current increases exponentially with temperature and doubles in magnitude for every 10 to 12 C increase. Even at low junction temperatures the effects of this current are important.

Since the saturation current flows in the emitter and base as well as in the collector circuit, the effects of I_{co} changes in the output depend on the type of circuit. The grounded-emitter circuit is exceptionally subject to such changes since it is usually designed for maximum current and voltage amplification and for large source resistances driving the base.

Such design is inimical to best high-temperature operation. However, since the grounded-emitter circuit yields both current and voltage gain with junction transistors, it is desirable for bistable flip-flops and some economical means of high-temperature stabilization must be achieved.

Temperature Compensation

Temperature compensation of an amplifier is usually achieved by cancellation of the transistor I_{co} with that of another transistor or by use of some thermally sensitive resistance. The former method is usually preferred since cancellation over a wider temperature range will be most effective for similar types of units. However, for a bistable switching circuit such as a flip-flop it is not possible to achieve compensation without introducing more transistors in each stage.

These compensating transistors must adequately match the active transistors in the flip-flop stages, especially at the highest temperature anticipated. This is particularly true because of the exponential dependence on temperature.

Considerable improvement in temperature stability can be achieved by appropriate resistances in the emitter and base circuits. This improvement is at the sacrifice of efficiency because of losses in the resistances and a reduction in signal swing for switching circuits such as the flip-flop.

A-C Amplifiers

The most useful application of this method is for a-c amplifiers where the swing and gain reductions can be eliminated by adequate bypassing. For bistable circuits and d-c amplifiers such bypassing results in large low-frequency attenuation that is usually unacceptable.

By operating the transistor with large collector currents and low collector voltages, the effects of relatively large I_{co} at elevated temperatures can be kept within the limitations of dissipation and maximum collector current ratings. Further, since in low-voltage high-current circuits, resistance values are low, the larger I_{co} at high temperature results in a smaller effect on output signal voltage.

This method is not economical of supply current but need not require excessive supply power because of low supply voltages. However, the requirement for large current is undesirable because of the requirements imposed on power-supply filtering when using a-c supplies as

TRANSISTOR CIRCUITS

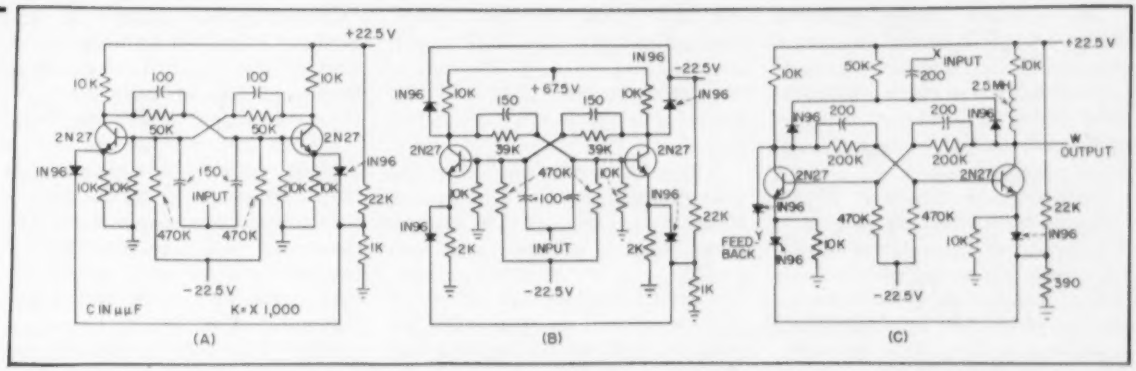

FIG. 1—Transistorized flip-flop uses diode switching in emitter circuit for temperature stabilization (A). Collector clamping improves high-frequency operation (B). Output inductance (C) improves interstage switching in binary counters

well as the increased power losses in conductors and connections. For systems where total power consumption and current drain are small this method is often the best.

Silicon Transistors

The higher work function involved in transporting thermally created carriers across the collector-base junction in silicon transistors results in I_{co} currents several orders of magnitude less than in germanium devices of similar ratings. This difference in work function results in a less perfect switch in the on condition since the collector voltage in saturation cannot drop as low as for germanium. Representative values are 1 volt for silicon and 0.1 volt for germanium.

Furthermore prices for established types of silicon transistors are higher than for germanium units of comparable rating. Eventually, however, the silicon transistor or a silicon-germanium alloy transistor may become the best solution to the temperature problem.

Circuit Discussion

The circuit shown in Fig. 1A employs bias stabilization in the emitter of a grounded- emitter amplifier. In addition it provides diode gating of the emitter stabilizing resistance to reduce the d-c degeneration in the on condition so that almost full output swing is provided. Since the stabilization is only required in the off condition, the on condition being aided by the saturation current, this arrangement makes full use of the stabilization.

The basic limitation is the use of two diodes, two emitter resistors, and a voltage return for the diodes for each flip-flop stage. The voltage return can be common for several stages, depending upon the permissible drain and impedance of the return voltage source. A separate voltage supply can be used or, if common battery operation is desired, a voltage divider can be used as shown in the circuits of Fig. 1.

Since the flip-flop is symmetrical the regulation of the divider is usually adequate. Calculation shows that for the transistor in the off state the stability factor is in the order of 2 to 3 depending upon transistor parameters. This compares favorably with the ultimate limit of unity for the stability factor. An unstabilized stage would generally have a factor in excess of 20.

Since the stabilization is applied only to the off transistor, the on transistor is not inhibited from going deeply into saturation. Since this effect is more pronounced at elevated temperatures, the transistor goes even further on and deeper into saturation. The resulting increased carrier storage slows down the transistor in changing from on to off and reduces the upper limit of switching speed.

This effect can be reduced by preventing the transistor from going into saturation. The price paid is another voltage source and another pair of diodes for clamping. Such a system incorporating both the bias stabilization and collector clamping for high-speed operation is shown in Fig. 1B. Results for both circuits are tabulated in Table I. An unstabilized circuit of similar design and with similar transistors consistently failed in operation at about 40 to 45 C.

The input trigger requirements are about 8 to 10 v but trigger rise time may alter the requirements. Improvement in triggering between stages can be achieved by peaking the output collector with an inductance as in Fig. 1C. The value of inductance is noncritical and can be 1 mh or less.

The transistors used were type 2N27. Representative data by the manufacturer show alpha = 0.95 to 0.995; alpha cut-off frequency = 1.0 mc, minimum; I_{co} at 30 v V_c = 30×10^{-6} amp.

Tone Keyer

Typical grounded-emitter characteristic families for junction

transistors show a portion of the family merging at low collector voltages and high collector currents. This is commonly called the saturation region.

The collector family generally shows a high dynamic resistance because of the almost horizontal slope of the curves in the nonsaturated region. The saturation region shows extremely low dynamic collector resistances.

Resistances in the order of 200 ohms or less are not uncommon in this portion of the collector family. This permits the use of the junction transistor as an a-c switch when driven from an appropriate impedance source. This property, not unlike the output impedance changes of a vacuum-tube cathode follower with bias, is used in the tone keyer.

The tone keyer shown in Fig. 2 consists of a source impedance, the shunting impedance of the control transistor and a grounded collector buffer amplifier. A second control transistor is included.

The source impedance is kept above 10,000 ohms by the series resistance. A blocking capacitor effectively prevents possible d-c components or return paths in the tone generator from effecting the keyer operation.

Pinching Diodes

Two 1N67A's are pinching diodes. Consider the input as a d-c signal. When the input is in the tone-on condition the first control transistor is off.

The second control transistor is on and its collector voltage is low. For this condition the two diodes are back biased by the collector voltages and present a high impedance at their junction. The tone is only slightly attenuated and the grounded collector stage gives full output.

When the input signal is in the tone-off condition the first control stage is heavily in saturation and presents a low collector impedance as well as a low collector voltage. The second control stage is now off and its collector is high. Both diodes are now conducting and are themselves low impedances.

The diode connected to the collector of the first control transistor ties the signal line to the low collector-to-ground resistance of the first stage and shorts the signal. The second control stage provides a path for d-c through the two diodes.

The first diode effectively ties the signal to the collector of the first control stage by assuring that the diode is forward biased throughout the a-c signal swing.

This prevents d-c transients through rectification of the signal in the pinching operation. The second control stage provides constant B+ drain so that use of the tone keyer in existing circuits does not upset voltage regulation. A cross-coupling capacitor between the collectors of the control transistors suppresses transients which could occur because of the time difference between the rise of one collector and the fall of the other.

The grounded collector is temperature stabilized by a 2,700-ohm emitter resistance. Larger values lead to greater stability but limit the power capabilities of the stage.

Use of the collector saturation region for the switching makes temperature effects on the control stages immaterial and temperature compensation is not used. Elevated temperatures can cause lowered collector voltages because of the amplifier I_{co} effect in the grounded-emitter stages but only extreme temperatures can cause saturation in the absence of an on signal. Overall operation was satisfactory to 58 C.

Leakage Effects

Since the switching is not perfect because the collector and diode impedances do not go to zero, there is tone-off leakage but this leakage is approximately 30 db below the tone-on state. For a 10,000-ohm source impedance this indicates a diode plus collector impedance of about 300 ohms.

The off leakage signal can be bucked out by injecting a portion of the tone-generator signal in opposition to the output signal. This method of cancellation of the residual level will result in only about 3-percent loss of tone-on signal

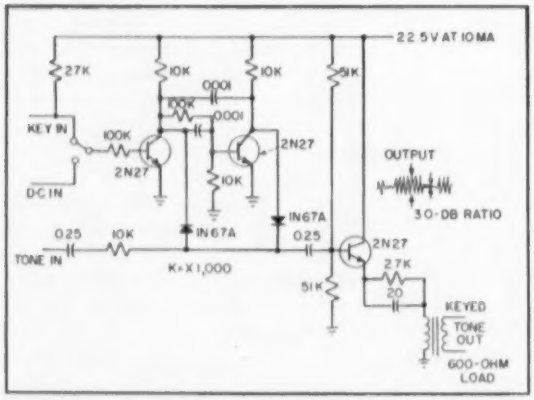

FIG. 2—Tone keyer consists of two transistor control stages and grounded-collector buffer amplifier. Either a d-c control signal or mechanical switching can be employed

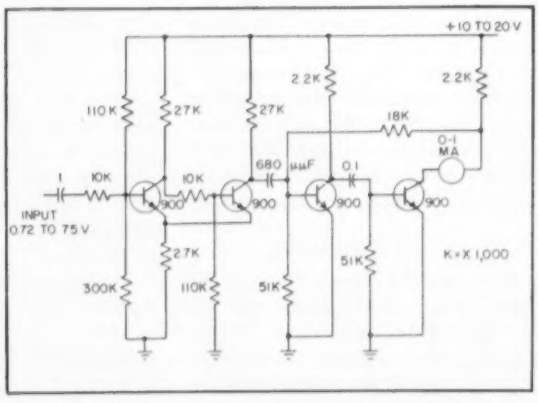

FIG. 3—Audio frequency depends upon triggered single-shot multivibrators to supply standardized pulses into integrating circuit at rates depending upon unknown frequency

when the initial on/off ratio is 30 db.

The buffer output was made grounded collector so that the high input impedance from the tone source plus the 10,000-ohm resistor would not be appreciably loaded during the tone-on state and yet would supply about 0 dbm to a 600-ohm line. This stage is conventional.

Operation is linear for inputs up to 1.0 volt. The base bias resistors were a compromise between high impedance and good temperature stability.

Total power consumption depends on the supply voltage but for the nominal design center value of 22.5 v, the drain is less than 10 ma from the signal battery. The major part of this power is taken by the buffer amplifier to allow it to supply 0 dbm to a 600-ohm load. Reduced output requirements would allow an increase in the 2,000-ohm emitter resistor and a proportionate decrease in current.

Signal input impedance to the tone is dependent on the keying state and varies from 10,000 to 40,000 ohms as determined by the base biasing resistors of the buffer amplifier and the 10,000-ohm resistor. Keying signal input resistance is a minimum of 100,000 ohms in the tone-off state. For applications requiring higher output levels, a stage of power amplification can be added to the grounded collector buffer.

Frequency Meter

Measurement of frequency may be accomplished by measuring the time average of a standardized pulse triggered from an incoming signal. Since the pulses are standardized, the time average is directly proportional to the occurrence rate or frequency of the pulses. For any given frequency the meter reading is proportional to the standardized pulse width and amplitude as well as the input frequency.

In the frequency meter shown in Fig. 3 a single-shot or monostable multivibrator generates the standardized pulses. A milliammeter in series with the normally off transistor collector provides a reading proportional to the input frequency. By inserting the milliammeter in the normally on collector lead a reading proportional to the period of the input signal could be developed.

Silicon transistors eliminate the effects of changes in ambient temperature normally found in germanium transistors. Further, silicon transistors have low reverse collector currents denoted by I_{co} so that there is virtually no zero current and thus no need for a zero-set adjustment.

Because the transistor makes an excellent switch, the amplitude of the single-shot pulse used as the standard pulse is essentially proportional to the supply voltage and the milliammeter reading for any given input frequency is nearly proportional to supply voltage. Since the circuitry is symmetrical insofar as the emitter and collector circuit loads are concerned, the supply drain is independent of the duty cycle of the single shot and hence is independent of input frequency or pulse width of the single shot.

This is desirable since the power-supply drain is steady, except for transient conditions. Hence power-supply regulation is not affected by input frequency changes or changes in standard pulse-width variations. Also, by having supply regulation independent of input frequency, while the meter calibration is almost directly dependent on frequency, a convenient means of meter full-scale calibration is obtained either by power-supply variation or by use of a series rheostat.

This method of scale calibration is effective for small changes and not for changes of 5 or 10 to 1 because of the possibility of excessive meter currents as well as possible excessive dissipation in the transistors.

For changes of 5 or 10 to 1 or more, the single-shot coupling capacitor can be switched to different values. The values shown are for full-scale meter readings of 300 to 1,000 cycles. The standard pulse widths should be less than half of the input signal period so that each input signal cycle is effective in triggering the multivibrator. The pulse width should be wide enough so the duty cycle of the lowest frequency will result in measurable average current flow through the meter.

In the event that other than a straight line frequency-scale reading is desired, a meter movement with shaped pole pieces could be used. Such movements can yield, for example, logarithmic scales expanded about a given region.

A two-transistor preamplifier provides adequate sensitivity and allows operation on sinusoidal waves. The preamplifier is essentially a transistorized Schmitt trigger. This circuit requires only 0.75 v rms or an equivalent peak input.

The minimum input impedance is no less than 10,000 ohms as determined by the series base resistance. With this resistance shorted out the sensitivity is increased so that only 0.3 v rms is required but the circuit presents nonlinear input impedances to the signal source.

Elimination of the input blocking capacitor allows the preamplifier to trigger on slow level changes and with the addition of a series adjustment-voltage for setting of the reference level, allows the circuit to measure frequency as referred to transitions about any arbitrary level.

Table 1—Characteristics of Transistor Circuits

Circuit	Frequency	Temp	Power Supply	Output
Stabilized, unclamped.....	20 kc	70 C	22.5 v @ 2 ma	15 v
	30 kc	25 C		15 v
Stabilized, clamped.....	50 kc	60 C	22.5 v @ 5 ma & 67.5 v @ 7 ma	16 v
	100 kc	25 C		16 v

Design Charts for

SUMMARY —— Rapid correlation of coupling-circuit performance can be achieved with parameters of a wide variety of double-tuned coupling transformers. Charts are particularly useful where power transfer is important, as in transistor i-f amplifiers. Several interesting problems are worked out to illustrate design procedure

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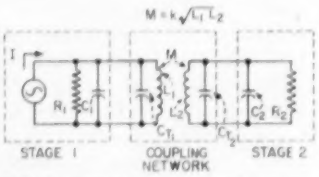

FIG. 1—Typical double-tuned transformer coupling network

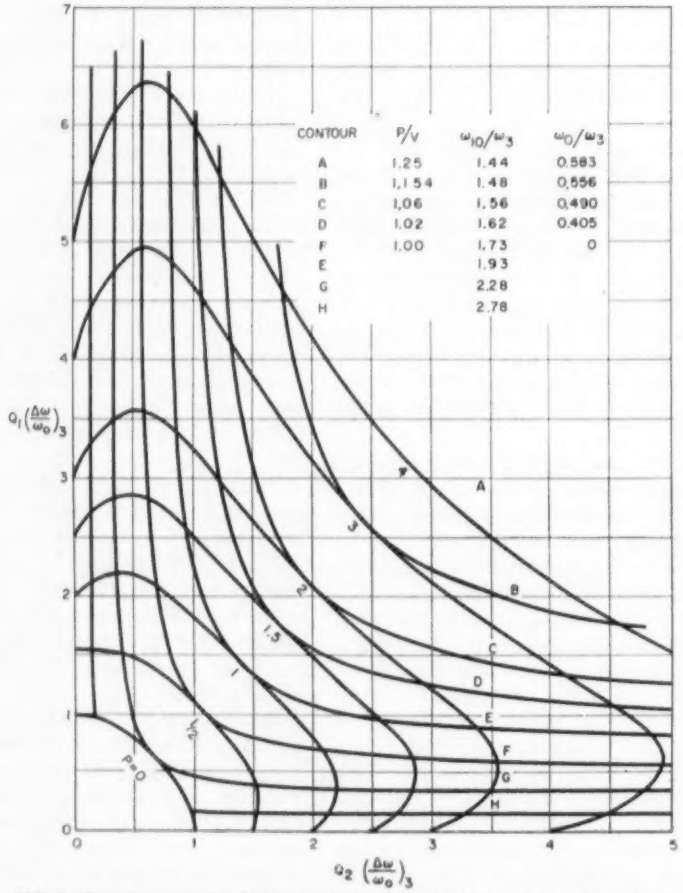

FIG. 2—Design curves for double-tuned transformers: $(\Delta\omega/\omega_o)_3$ is relative bandwidth at half-power points of pass band

IN DESIGN of transistor video i-f amplifiers, the problem of coupling between stages may be approached from the point of view of power transfer from the output terminals of one stage to the input terminals of another. Usually this network is in the form of a single or double-tuned transformer. The design charts described in this article are applicable to a wide variety of coupling circuits.[1]

A typical coupling network is illustrated in Fig. 1. The transformer couples power from stage 1 to stage 2. The output impedance of stage 1 is represented by the parallel combination of R_1 and C_1' and the input impedance of stage 2 by R_2 and C_2'. The tuning capacitances of the primary and secondary are C_{T1} and C_{T2}. For convenience $C_1 = C_1' + C_{T1}$, the total primary capacitance, and $C_2 = C_2' + C_{T2}$, the total secondary capacitance.

The power transfer of this and many other coupling networks[2] is given as a function of frequency and circuit constants by:

$$\frac{P}{P_o} = \frac{(1+p)^2}{\left\{[1+p-(\Delta\omega/\omega_o)Q_1(\Delta\omega/\omega_o)Q_2]^2 + [(\Delta\omega/\omega_o)Q_1+(\Delta\omega/\omega_o)Q_2]^2\right\}} \quad (1)$$

Tuned Transformers

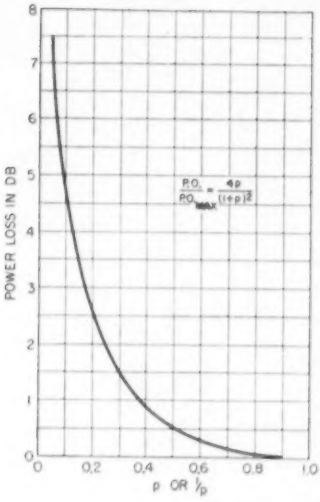

FIG. 3—Power loss for matched case, $p = 1$, versus p

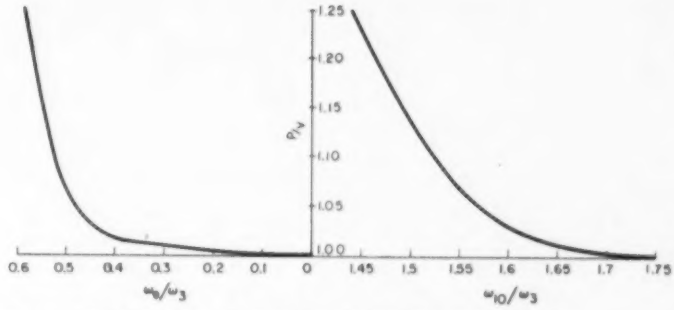

FIG. 4—Relation between shape factors for different bandwidth ratios

where P/P_o = relative power transfer, the power transfer at frequency ω divided by the power transfer at the center of passband ω_o; $(\Delta\omega/\omega_o)$ = relative bandwidth, with $\Delta\omega$ the difference between the upper and lower frequencies at which the relative power transfers equal P/P_o; Q_1 = primary circuit Q; Q_2 = secondary circuit Q; $p = K^2Q_1Q_2$, the source-to-load impedance match parameter; K^2 = an effective coupling coefficient.

Exact relations for primary and secondary circuit Q's, the effective coupling coefficient and the conditions for tuning depend on the type of coupling circuit. These relations are given in a chart for four types of double-tuned transformers. It can be seen that a given transformer winding is tuned with the other short-circuited when it is parallel tuned or with the other open-circuited when it is series tuned.

To obtain a design chart from Eq. 1 relating the relative bandwidth where the power transfer is 3 db below the midband value, denoted $(\Delta\omega/\omega_o)_3$, let $P/P_o = \frac{1}{2}$. The chart is shown in Fig. 2 with curves for different values of p from 0 to 4. The transformer design corresponding to every pair of values of $(\Delta\omega/\omega_o)_3 Q_1$ and $(\Delta\omega/\omega_o)_3 Q_2$ prescribed by a given p contour will have the same midband power transfer. The curve for $p = 1$, the critical coupling contour, is the same as that in the literature.[3]

For any given transformer, the center-frequency power transfer is related to its maximum value $P_{o\,max}$ by

$$P_o/P_{o\,max} = 4p/(1+p)^2 \qquad (2)$$

Significance of p

The value p may be thought of as the ratio of source resistance to the load resistance reflected into the primary. When $p = 1$, the source and load are matched, the power transfer is at its maximum value. The power transfer for other values of p is shown by the plot of Eq. 2 in Fig. 3.

Another interpretation may be given p. Critical coupling is that coupling which affords maximum power transfer and corresponds to the matched condition $p = 1$. Then $p = 1 = K^2Q_1Q_2$ or $K^2_c = 1/(Q_1Q_2)$ where K_c = critical coupling coefficient. Hence, $p = (K/K_c)^2$, the square of the ratio of the coupling coefficient to the critical value of this coefficient. The quantity $n = K/K_c$ has been used in the literature[4] for plotting universal curves for coupling circuits. Therefore $p = n^2$.

Shape Contours

In addition to the curves for different values of p in Fig. 2, there is another family of curves of constant pass band shape, which are concave outward from the origin. Every pair of values of $(\Delta\omega/\omega_o)_3 Q_1$ and $(\Delta\omega/\omega_o)_3 Q_2$ on a given shape contour will have the same pass band shape.

The pass band shape is described by: the skirt steepness, defined as the ratio of the relative bandwidth where the relative power transfer is -10 db to that where the relative transfer is -3 db (W_{10}/W_3); the peak-to-valley transfer response ratio (P/V); the relative bandwidth at the response peaks expressed in a ratio with the 3-db relative bandwidth (W_c/W_3). The last two factors have meaning only when the response is double peaked.

The one-to-one correspondence between the factors is graphi-

Design Charts for Tuned Transformers (Continued from p 183)

cally illustrated by the curves in Fig. 4.

For single-peaked responses, there are no real values of P/V and W_s/W_p. The shape contour for $P/V = 1$ separates the overcoupled and undercoupled regions of the $Q_1(\Delta\omega/\omega_o)_3 - Q_2(\Delta\omega/\omega_o)_3$ plane. This curve is defined by $p = \frac{1}{2}(Q_1/Q_2 + Q_2/Q_1)$, which may be reduced to the definition of transitional coupling, $K^2_t = \frac{1}{2}(1/Q_1^2 + 1/Q_1^2)$. Transitional coupling is the point at which the transfer response changes between single and doubled peaked.

Figure 2 permits the design of a transformer which will have

CIRCUIT	TUNING	k^2	Q_1	Q_2
PARALLEL-PARALLEL	$\omega_0^2 = \frac{1}{L_1 C_1 (1-k^2)} = \frac{1}{L_2 C_2 (1-k^2)}$	k^2	$\omega_0 R_1 C_1 = \frac{R_1}{\omega_0 L_1 (1-k^2)}$	$\omega_0 R_2 C_2 = \frac{R_2}{\omega_0 L_2 (1-k^2)}$
SERIES-SERIES	$\omega_0^2 = \frac{1}{L_1 C_1} = \frac{1}{L_2 C_2}$	k^2	$\frac{1}{\omega_0 R_1 C_1} = \frac{\omega_0 L_1}{R_1}$	$\frac{1}{\omega_0 R_2 C_2} = \frac{\omega_0 L_2}{R_2}$
PARALLEL-SERIES	$\omega_0^2 = \frac{1}{L_1 C_1} = \frac{1}{L_2 C_2 (1-k^2)}$	$\frac{k^2}{1-k^2}$	$\omega_0 R_1 C_1 = \frac{R_1}{\omega_0 L_1}$	$\frac{1}{\omega_0 R_2 C_2} = \frac{\omega_0 L_2 (1-k^2)}{R_2}$
SERIES-PARALLEL	$\omega_0^2 = \frac{1}{L_1 C_1 (1-k^2)} = \frac{1}{L_2 C_2}$	$\frac{k^2}{1-k^2}$	$\frac{1}{\omega_0 R_1 C_1} = \frac{\omega_0 L_1 (1-k^2)}{R_1}$	$\omega_0 R_2 C_2 = \frac{R^2}{\omega_0 L_2}$

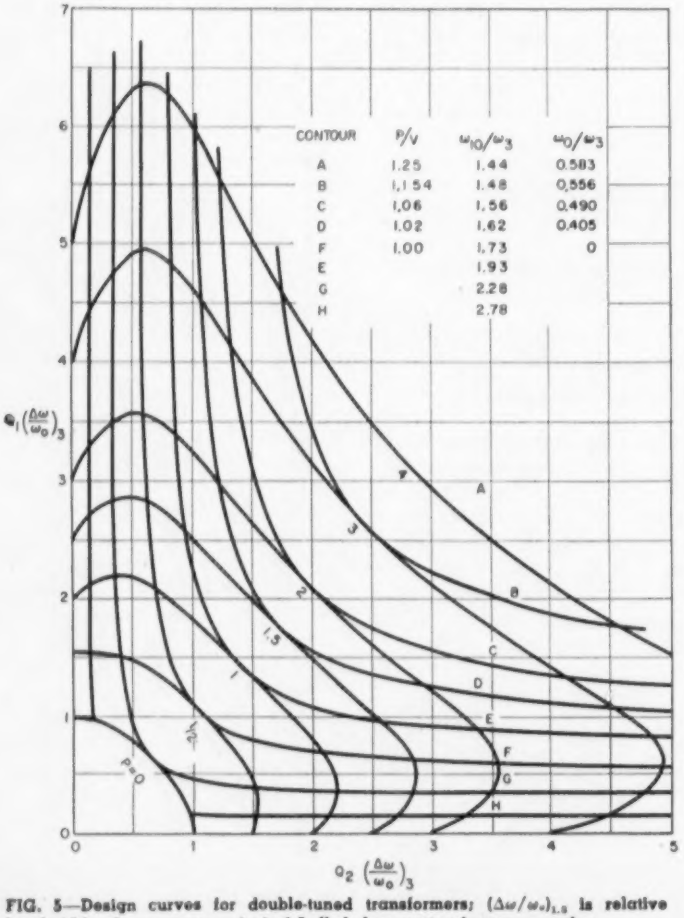

FIG. 5—Design curves for double-tuned transformers; $(\Delta\omega/\omega_o)_{1.5}$ is relative bandwidth where power gain is 1.5 db below center frequency value

the desired 3-db bandwidth, a known pass-band shape and percent of maximum power transfer. If a number of stages are cascaded, the transfer responses in db are additive.

To permit the design of transformers to be used in pairs or triples, design curves for a single transformer are given in Fig. 5 and 6 in terms of 3/2-db bandwidth, $(\Delta\omega/\omega_o)_{1.5}$, and 1-db bandwidth, $(\Delta\omega/\omega_{1o})$.

When two or three, respectively, of these transformers are cascaded, these bandwidths become the overall 3-db bandwidth. The shape factors on these curves are expressed for a single transformer and they must be interpreted for cascading. For example, $(W_s/W_{s/3})$ for one transformer is (W_{10}/W_s) for a pair; $P/V = 1.1$ for one transformer means that for a triple P/V is $(1.1)^3$.

Chart Contour Interpretation

Several properties of coupled tuned circuits are apparent from the design charts.

The transitional coupling contour $(P/V = 1)$ and the critical coupling curve $(p = 1)$ divide the $Q_1(\Delta\omega/\omega_o) - Q_2(\Delta\omega/\omega_o)$ plane into three regions. Referring

to Fig. 2, 5 or 6: between $p = 1$ and the axes, the circuits are undercoupled and single peaked; between $p = 1$ and $P/V = 1$, they are overcoupled but single peaked; outside $P/V = 1$, they are overcoupled, double peaked.

Different degrees of impedance match or center frequency power transfer may be obtained with the same pass band shape. For critical or overcoupled transformers, ($p \geq 1$) maximum power transfer and best impedance match for a given pass band shape occurs when the Q's are equal. For an undercoupled ($p < 1$) transformer, this occurs at two values of Q_1/Q_2.

Moving along a contour of constant power transfer (constant p), various shape factors may be obtained with the same impedance match. It is always possible to obtain a response which is not double peaked if the Q's are made sufficiently unequal. For $p \geq 1$, it is always possible to achieve transitional coupling, at equal Q's for $p = 1$ and at two values of Q_1/Q_2 for each $p > 1$.

Changing Coupling

If Q_1 and Q_2 are fixed and coupling coefficient k is varied, the performance of the transformer can be seen on the design curves by considering radial lines Q_1/Q_2 equal to a constant as illustrated in Fig. 7.

For example, if the coupling is increased, the design point moves along the given radial line in the direction of increasing p, since $p = K^2Q_1Q_2$. As a result, the center-frequency power transfer may increase or decrease, depending on whether the original value of p was less or greater than unity. The 3, 1.5, or 1-db bandwidth will increase since $Q_1(\Delta\omega/\omega_o)$ increases. The shape of the pass band will tend toward double peaking and steeper skirts and the spacing between the peaks, if they exist, will increase.

For any given value of p there is a maximum value of $Q_1(\Delta\omega/\omega_o)$. For the critical coupling contour this value, from Fig 2, is 2.2. Thus, if an impedance match is desired ($p = 1$), the maximum 3-db bandwidth which may be obtained is $(\Delta\omega/\omega_o)_3 = 2.2/Q_1$. With Q_1 too large, this bandwidth may be inadequate.

From another viewpoint, when $(\Delta\omega/\omega_o)_3$ and Q_1 are both specified, $Q_1(\Delta\omega/\omega_o)_3$ is greater than 2.2 if Q_1 is too large. It is, therefore, impossible to match this source for the required band.

It is possible to load the source with a damping resistor, but a greater power transfer can be obtained by designing for the best impedance match at the given value of source Q. In Fig. 8, point A will give the maximum power transfer if no damping resistance is added. It is the point where line $Q_1(\Delta\omega/\omega_o)$ is tangent to the p contour which has the value of p closest to one.

If the source is dampened so the effective source $Q_1'(\Delta\omega/\omega_o) = 2.2$ then point B will give the maximum power transfer. However, there is now a loss in damping resistance R_D which has been added across the primary.

The ratio of the maximum values of power output without and with the damping resistance is $P_o/P_o' = 1.82Q_1\ (p_A + 1/p_A + 2)\ (\Delta\omega/\omega_o)_3$. A plot of this expression, Fig. 9, shows the db loss resulting from changing design points from A to B, versus the source $Q_1(\Delta\omega/\omega_o)_3$. The positive slope of this curve shows that any partial damping will not be as efficient as point A (no damping).

Examples

(1) The output impedance, including strays, of a common-base

(continued on p 186)

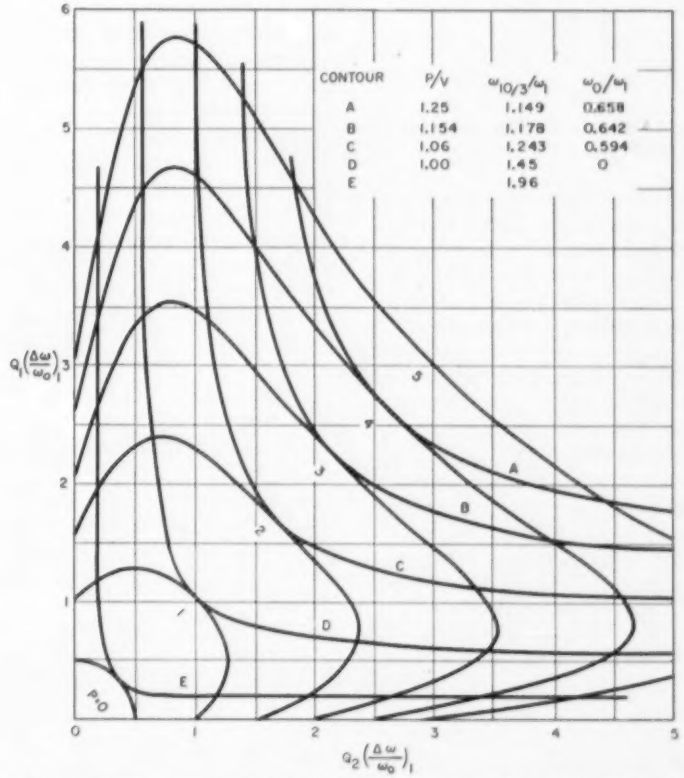

FIG. 6—Design curves for double-tuned transformers; $(\Delta\omega/\omega_o)_3$ is relative bandwidth at half-power points

Design Charts for Tuned Transformers (continued from p 185)

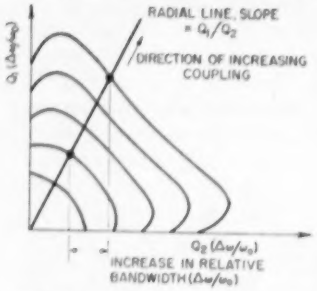

FIG. 7—Increased coupling effects

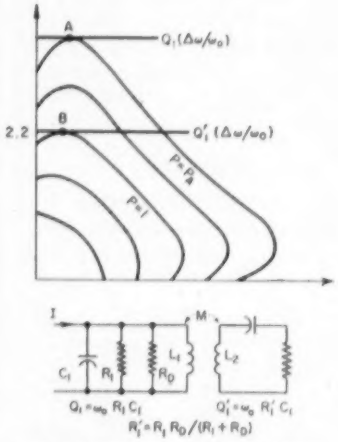

FIG. 8—Effect of addition of damping resistance

neutralized transistor amplifier stage appears as a 7,500-ohm resistance in parallel with a 10$\mu\mu$f capacitor. The load resistance is 500 ohms. Design a parallel-series double-tuned transformer for maximum power transfer at a frequency of 21.25mc, with a relative bandwidth of 0.2. $Q_1 = \omega_0 R_1 C_1 = (133 \times 10^6)(10^{-11})(7{,}500) = 10$.

Since $Q_1 \times$ (relative bandwidth) $= 10.0 \times 0.2 = 2$, it can be seen from Fig. 2, that the matched condition, $p = 1$, is possible. From Fig 2, $Q_2 = 0.8/0.2 = 4$. The primary inductance is then $L_1 = 1/\omega_0^2 C_1 = 1/(133 \times 10^6)^2(10^{-11}) = 5.64 \times 10^{-6}$ hy. The coefficient of coupling is found; $p = 1 = K^2 Q_1 Q_2 = [k^2/(1 - k^2)]\, Q_1 Q_2$, $k = 0.156$. The secondary inductance is $L_2 = Q_2 R_2/\omega_0 (1 - k^2) = 4(500)/(133 \times 10^6)(0.9756) = 15.4$ μhy. The capacitance to tune the secondary is $C_2 = 1/\omega_0^2 L_2 = 1/(133 \times 10^6)^2 (15.4 \times 10^{-6}) = 3.65$ $\mu\mu$f.

From Fig. 2, the ratio of the 10-db to 3-db bandwidths may be interpolated as 1.86. The response is single peaked.

(2) If, in the preceding problem, the output resistance were 17,000 ohms, what would be the transformer design for maximum power transfer?

The primary Q would be increased by the factor 17,000/7,500: $Q_1 = 10\ (17/7.5) = 22.7$ and $Q_1(\Delta\omega/\omega_0)_3 = 0.2 \times 22.7 = 4.54$.

Referring to Fig. 2, it can be seen that the matched case cannot be achieved with $Q_1(\Delta\omega/\omega_0)_3 = 4.54$. To obtain minimum mismatch loss the contour with its peak tangent to $Q_1(\Delta\omega/\omega_0)_3 = 4.54$, $p = 2.68$, will be used. From Fig. 3, $p = 2.68$ corresponds to a loss of about 1 db with respect to the matched case. This is the minimum loss that can be achieved with a double-tuned transformer in this stage. The value of Q_2 at this peak may be interpolated as 2.83.

The primary inductance is the same as in the first example. The coupling coefficient is: $k^2/(1 - k^2) = p/Q_1 Q_2$, $k = 0.20$. The secondary inductance is $L_2 = Q_2 R_2/\omega_0 (1 - k^2) = (2.83)(500)/(133 \times 10^6)(0.96) = 11.0$ μhy. The capacitance to tune the secondary is $C_2 = 1/\omega_0^2 L_2 = 5.09$ $\mu\mu$f.

(3) What would be the effect in the first example of a 10-percent increase in the coefficient of coupling?

The increased coupling coefficient is 1.1 (0.156) = 0.172. The primary Q is not changed and the secondary Q is only negligibly changed by the ½-percent variation in $(1 - k^2)$.

Parameter p is $(0.172)^2\ (10)\ (4)\ [1 - (0.172)^2] = 1.22$. From Fig. 3, the power loss with respect to the matched case is 0.04 db. Moving along a radial line $= Q_1/Q_2 = 10/4 = 2.5$ to the interpolated $p = 1.22$ curve on Fig. 2, W_{10}/W_3 changes from 1.86 at $p = 1$ to 1.79 at $p = 1.22$.

From this shift along the radial line, the value of $Q_1(\Delta\omega/\omega_0)_3$ changes from 2 to about 2.16. Since Q_1 does not change, the 3-db relative bandwidth has increased from 0.2 to (0.2) (2.16/2.0) = 0.216. Thus, the 10-percent increase in k results in a power loss of 0.04 db, an increase of 8 percent in the 3-db bandwidth and a decrease in W_{10}/W_3 of nearly 4 percent.

(4) Three identical transistor amplifiers each having an output Q of 17.75 are to be cascaded using three double-tuned transformers. What is the minimum insertion loss for the three transformers, neglecting coil losses? The overall 3-db relative bandwidth is to be 0.2. What will be the shape factors of the overall pass band?

$Q_1\ (\Delta\omega/\omega_0) = Q_1(0.2) = 3.55$

Referring to Fig. 6 at $Q_1(\Delta\omega/\omega_0)_3 = 3.55$, the minimum value of p is 3. Hence, from Fig. 3, the loss is 1.25 db per stage or an overall loss due to mismatch of 3.75 db. From Fig. 6, $P/V = 1.02$ for one stage, or $1.02^3 = 1.06$ for three stages. Also $W_{10/3}/W_3 = 1.37$ for one stage, hence $W_{10}/W_3 = 1.37$ for three stages. The separation of the peaks is about $W_0/W_1 = 0.51$ for one stage or $W_0/W_3 = 0.51$ for three.

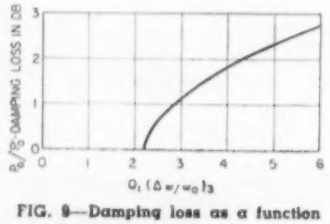

FIG. 9—Damping loss as a function of undamped source Q

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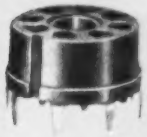

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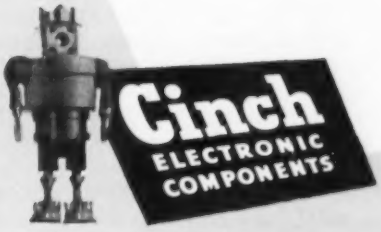

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Bandwidth-Rise Time Chart

By M. DAVID PRINCE

Research Engineer
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Georgia Institute of Technology
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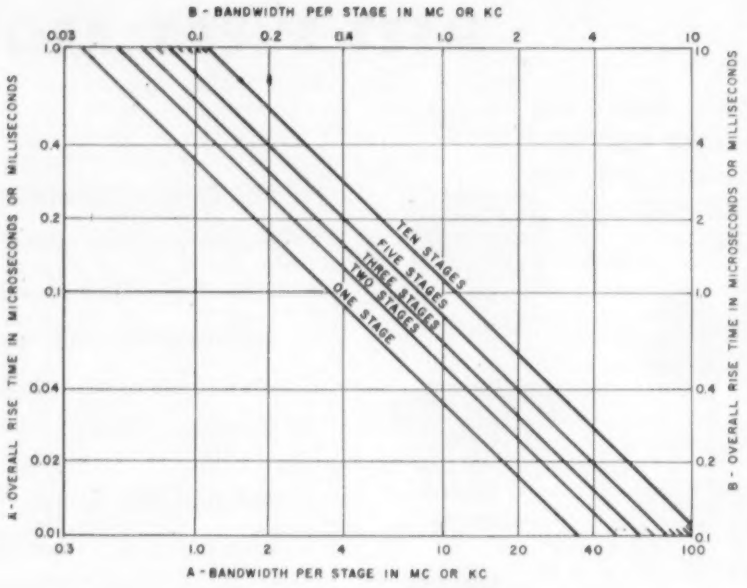

SUMMARY — Straight-line chart relates bandwidth and rise time over wide frequency range for 2 to 10 pulse-amplifier stages in cascade. Overall rise time of amplifier can also be determined

THE CHART presented here solves graphically two equations often used in pulse-amplifier design. The first applies to a single stage with less than 5-percent overshoot and relates the rise time to the bandwidth by the approximate empirical formula: (Rise Time) × (Bandwidth) = 0.35.

This equation also applies to an amplifier containing more than one stage, in which case the rise time and the bandwidth both apply for the overall amplifier.

The second equation relates the rise time of an amplifier consisting of a number of identical stages in cascade with the rise time of each stage. This relation, which applies if the overshoot of each stage is less than 3 percent, is

Overall rise time = (Rise time per stage) $\times \sqrt{\text{Number of stages}}$.

Care must be taken to use the *A* scales together or the *B* scales together, and to use microseconds and magacycles together or milliseconds and kilocycles together, as noted on the graph.

Examples

Three examples illustrate several applications of the chart.

(1) The bandwidth of a single stage is 4 mc. What is the rise time of five identical stages connected in cascade?

Enter chart at 4-mc bandwidth per stage. Go up to five-stages line, then over to rise time in microseconds and read 0.2 microsecond.

(2) The rise time of one stage is 10 microseconds. What is the rise time of ten stages in cascade.

Enter chart with rise time at 0.01 milliseconds. Intersection with one-stage line gives an equivalent bandwidth for a single stage of 35 kc. Move along 35-kc line to ten-stages line. Read on *A*-scale at 0.032 millisecond or 32 microseconds the rise time of ten stages in cascade.

(3) An overall effective bandwidth of 3.5 mc is required in a system. How many cascaded isolation amplifiers of 6-mc bandwidth can be used?

Enter the bandwidth scale at 3.5 mc and read up to the one-stage line. On the rise-time scale, the 3.5-mc overall bandwidth corresponds to a 0.1-microsecond overall rise time. Now, read over on the 0.1-microsecond rise-time line to the intersection with the 6-mc bandwidth line. This point of intersection indicates that three amplifiers can be connected in cascade without degrading the bandwidth beyond 3.5 mc.

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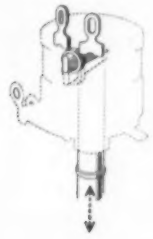

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Single and dual types of Mallory carbon controls are now available with this new switch . . . and with an improved carbon element that has even greater stability, better wearing quality and lower noise than ever before. Write or call Mallory for full details.

* * *

Long-Lasting "Floating Ring" Switch also in Rotary Model

The new "floating ring" contact design is also available in a switch with conventional rotary action, on Mallory single and dual carbon controls. It gives exceptionally long service . . . positive snap action "feel" . . . protection against loss of spring tension during overloads. Write to Mallory for data.

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Electrons At Work

Edited by ALEXANDER A. McKENZIE

Tomorrow's Electronic Light

The panels shown are the only source of light used to take photograph and demonstrate the variations in brightness which can be obtained

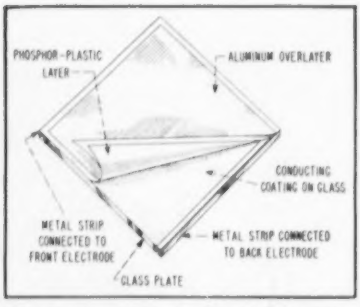


FIG. 1—Rear view of electroluminescent cell showing method of construction and placement of electrodes

ELECTROLUMINESCENCE was first discovered by French investigator Georges Destriau who explored this new phenomenon.

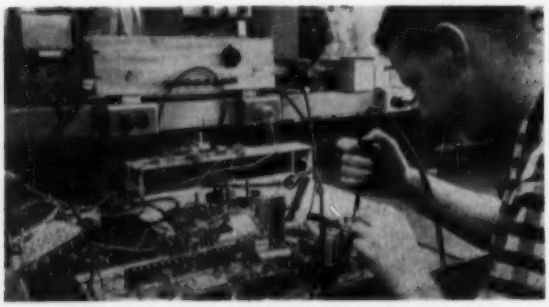
In 1947 he was able to publish a paper that set forth many of its properties. It represented a fourth method of exciting light from phosphors. Earlier methods employed x-rays, ultraviolet light and cathode rays.

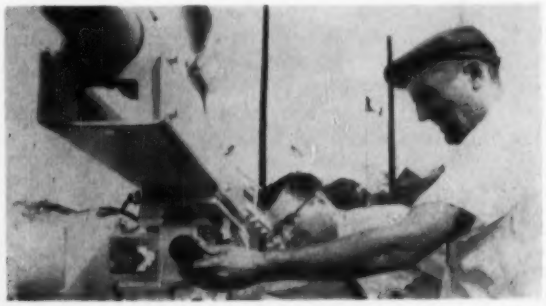
An electroluminescent cell is made by sandwiching phosphor between two conducting plates as shown in Fig 1. It comprises a glass plate bearing a transparent, conducting coating. On this conducting coating is sprayed a mixture of phosphor powder in a plastic binder and on top of this phosphor layer is evaporated a film of aluminum, which acts as a second conducting contact for the cell.

At present, red phosphor appears to be entirely unresponsive at low frequencies but becomes visible at high frequencies. The green, blue and yellow phosphors can be mixed to give white. .

Electroluminescence is also dependent on frequency. One phosphor, when operated at 60 cps and 600 volts emits green light, but if the frequency is changed to 10,000 cps, it emits blue light. Hence, in a single material the color can be shifted by changing the frequency. Another phosphor appears white at low frequencies but on increasing the frequency to 10,000 cps it be-

Experimental Equipment Checks Missile Ideas





Guidance circuits for Air Force ballistic missiles are set up on broadboard (left) at Bell Labs. Program includes two intercontinental missiles, Atlas and Titan as well as Thor, an intermediate range missile. Optical and electronic tracking devices at right

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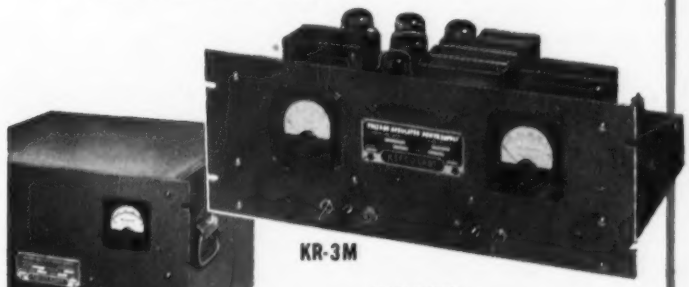
REGULATION: Less than 0.2 volts for line fluctuation from 105-125 volts and less than 0.2 volts for load variation from 0 to maximum current.

RIPPLE: Less than 3 mv. rms.

STABILITY: The output voltage variation is less than the regulation specification for a period of 8 hours.

RECOVERY TIME: Less than 50 microseconds. The excursion in the output voltage during the recovery period is less than the regulation specification.

OUTPUT IMPEDANCE: Less than 0.1 ohms from 20 cycles to 100KC. Less than 0.5 ohms from DC to 20 cycles. Many units have very much lower output impedance.



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KR-18MC

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KR17	100-200	has two	19"	12¼"	17"	$625
KR18	195-325	15 Amp.	19"	12¼"	17"	$695
KR19	295-450	outputs	19"	12¼"	17"	$695

600 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR 8	0-150	Each supply	19"	10½"	13"	$330
KR 5	100-200	has two	19"	10½"	13"	$240
KR 6	195-325	10 Amp.	19"	10½"	13"	$240
KR 7	295-450	outputs	19"	10½"	13"	$250

300 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR 12	0-150	Each supply	19"	7"	11"	$270
KR 3	100-200	has two	19"	7"	11"	$180
KR 4	195-325	5 Amp.	19"	7"	11"	$180
KR 10	295-450	outputs	19"	7"	11"	$190

125 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR 11	0-150	Each supply	19"	7"	11"	$180
KR 1	100-200	has one	19"	7"	7½"	$ 90
KR 2	195-325	3 Amp.	19"	7"	7½"	$ 90
KR 9	295-450	output	19"	7"	7½"	$ 97

To include 3" Current and Voltage Meters, Add M to Model number (e.g. KR 16-M) and Add $30.00 to the Price.
To include Dust Cover and Handles for Table Mounting, Add C to Model number (e.g. KR16-C) and Add $10.00 to the Price.
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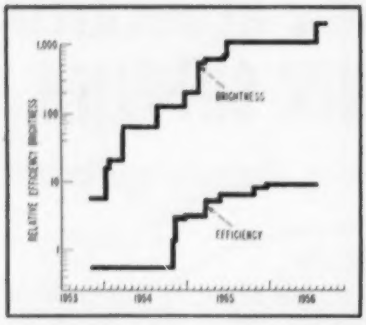


FIG. 2—Curves show progress in obtaining brightness and efficiency from electroluminescent characteristics of powdered phosphors

comes pink in color.

By placing four completely transparent electroluminescent cells one behind the other and changing the frequency, each cell can be excited one after the other by a resonant circuit. Thus at 8,000 cps blue appears, at a slightly higher frequency green, at a still higher frequency yellow or orange and at about 18,000 cps red. This has applications either for traffic signals or for a flat color-television display. This development is now being investigated at the Westinghouse Research Laboratories in Pittsburgh.

Transistor oscillator circuits are presently used to obtain the high-voltage variable-frequency source of power for the electroluminescent cells.

When operating at 60 cps and 110 v one cell gives a brightness of about 2½ foot-lamberts while at 220 volts and 60 cycles a second cell gives about 8 or 10 foot-lamberts, which is about one fourth as bright as a television screen.

Figure 2 shows the increase in both brightness and efficiency that has been obtained since 1953. Near the end of 1953 a brightness of only five foot-lamberts could be obtained, which is considerably less than the brightness of typical television screens. Recently 2,000 foot-lamberts have been obtained, higher than the surface brightness of a 40-watt fluorescent lamp.

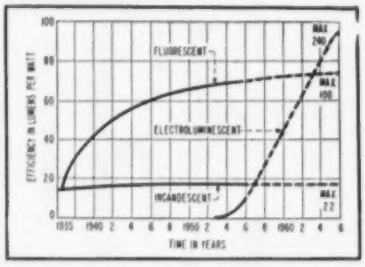


FIG. 3—Efficiency of electronic light source compared to present sources. Future expectations have been extrapolated to 1965 on the basis of current knowledge of materials and methods

Figure 3 shows the future possibilities of electroluminescence in terms of efficiency.

Overseas Aircraft Get Printed Weather

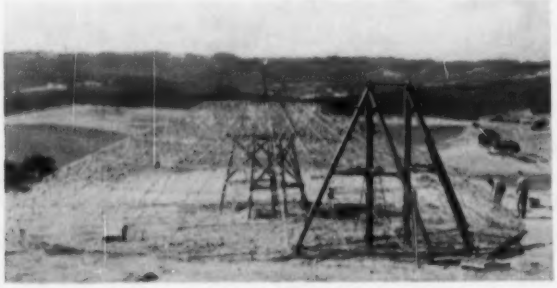
TRANSATLANTIC flight tests of radioteleprinter transmissions to aircraft are being carried out by Trans-Canada Airlines. Broadcasts of aerological information, which now constitute about 80 percent of voice-channel traffic, could be diverted to NARCAST (ELECTRONICS, p 20, Oct. 1956) if the system proves satisfactory.

The experiment is backed by leading overseas airlines that have designated TCA to carry out tests. Technical details of the equipment developed by Federal Telecommunication Laboratories are given below. So far, satisfactory signals have been received for well beyond half the distance from one transmitter to the other.

The two transmitters now in operation are at Chatham, New Brunswick on 118.80 kc and Galdenoch, Scotland on 121.60 kc. Transmitter radio frequencies can be set anywhere in the 70 to 150 kc region. The receiver supplied by FTL provides four crystal-controlled channels in this band with the ability to supply ten channels if necessary.

Narrow-band frequency shift keying is used at the transmitters. The minimum predetector bandwidth required to provide good reproduction of 22 millisecond tele-

Field Studies Of New Propagation Mechanisms



Assembly begins on the new antenna to be used in propagation studies over the range 100 to 1,000 mc. The transportable shelter (right) houses transmitting equipment. Sponsored by the Air Force, Stanford Research Institute will carry out a program designed to determine characteristics of radio-signal scattering and reflection by meteor trails. Reflection of radio waves by the ionization associated with the aurora will likewise be studied

surprise

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printer pulses is approximately 150 cps. To use as small a part of the frequency spectrum as possible, the system has been designed to employ this minimum required passband width.

The magnitude of the frequency shift has therefore been tailored to this bandwidth and has deviation capabilities of plus and minus 70 cps. Deviation being used in the present tests is plus and minus 20 cps. The receiver bandpass circuitry has been designed to provide a Gaussian response shape to minimize the phenomenon of overshoot and ringing that can result when fsk pulses, and/or impulse type noises are fed to pass-band shapes having a high rate-of-cutoff.

The frequency-shift keyer that drives the transmitters is based upon a crystal oscillator. It is made to produce the desired frequency deviation by properly keying the reactance presented to the crystal by the oscillator circuit. Through the use of complete crystal control

Demonstration setup of the NARCAST receiving equipment shows recessed loop, fsk receiver and 35-pound Creed printer

in both transmitter and receiver, the overall equipment satisfies in a reliable manner the frequency accuracy and stability required by this narrow band system.

The receiver has a noise figure of approximately 2 db and therefore requires 0.02 microvolt in series with 100 ohms to produce a 1-to-1 carrier-to-noise ratio.

To minimize local electric field noise pickups, a loop antenna is supplied with the equipment and to provide omnidirectional coverage an iron-core crossed-loop antenna system has been developed. This antenna system is available in both an externally mounted tear-drop housing and in a flush-mounted design.

The tear drop units have a conversion factor of 0.013 between microvolts per meter of field strength and the open-circuit microvolts in series with 100 ohms, which are available at the output terminals. The loop-antenna-receiver combination therefore requires approximately 1.5 microvolts per meter of field strength to produce a 1-to-1 carrier-to-noise ratio before detection.

The impedance transforming network that is part of the antenna system has been designed to accommodate any practical length of r-f cable required between antenna and receiver.

Radio Communication Through Long Tunnels

Twin-lead cable suspended in Pennsylvania Railroad Hudson River tunnel is kept as far from wall and as near passing trains as possible

COMMUNICATIONS between moving railroad trains and stations at either end of long tunnels is not feasible using frequencies between 25 and 1,500 mc and conventional radio techniques.

Experiments carried out by engineers of Bell Telephone Laboratories in the Pennsylvania Railroad's North (Hudson) River tunnel at about 150 mc show that it is possible to obtain satisfactory communications up to about 6,000 feet employing twin-lead cable such as RG-86/U suitably located in the tunnel.

▶ **Multiple Antennas**—Initial tests indicated that, with some 18 db loss per 100 feet of tunnel at 150 mc, 13 or 14 base stations spaced 1,000 feet apart in each of the two tubes would be necessary. A decision to try effectively inert equipment provided incentive to use a series of antennas within the tunnel fed by a suitable transmission line.

For the sake of economy, RG-8/U cable having a loss of about 2.7 db per 100 feet at 150 mc was installed. Five antennas were bridged at 500-foot intervals across the cable. While this arrangement was satisfactory, results obtained when trying to extend the range proved unfeasible for a tunnel greater than some 4,900 feet.

During the course of experiments, it was discovered that signals were being picked up from the cable itself. From further data collected it was concluded that a transmission line having appreciable external field but with considerably lower attenuation than RG-8/U

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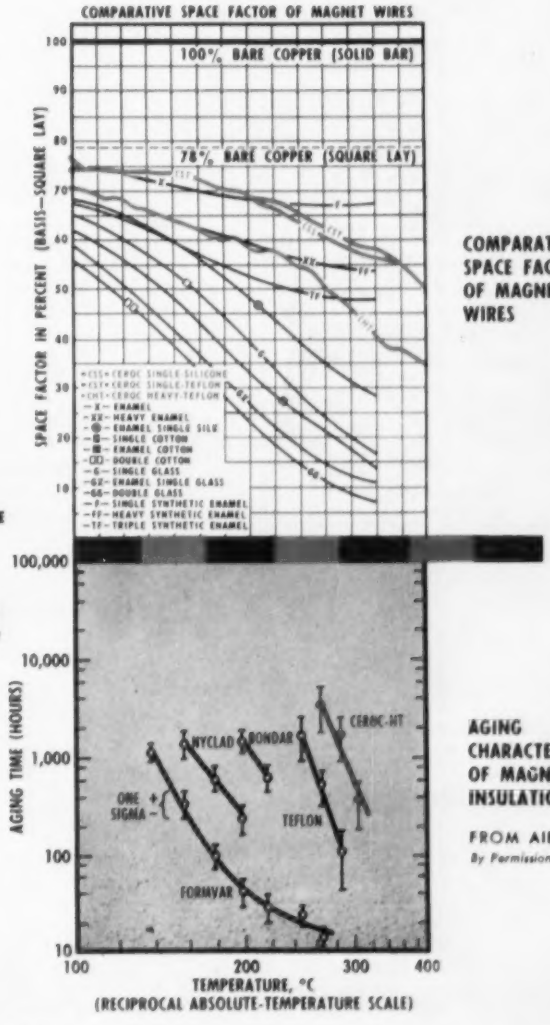

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cable would extend coverage.

Accordingly, RG-86/U solid dielectric parallel-pair cable (similar to but heavier than television ribbon line) was installed so that it was as close as possible to the mobile antennas. It was located in a plane about a foot below and 6½ feet removed from the car and locomotive antennas.

Although measurements showed this line to have a loss of 1.3 db per hundred feet (somewhat higher than its advertised loss of 0.6 db) it was found that a 30-watt transmitter was adequate for communications over a distance of 6,000 feet.

The full technical report of this work was presented at Wescon by Newton Monk of Bell Telephone Laboratories and will be published in the Transactions of the Professional Group on Vehicular Communications. It is abstracted here with permission.

Retarding Field Oscillator

Retarding field oscillator tube built at Ohio State for WADC. Output is taken from waveguide fitting at right and tuning is adjusted at top

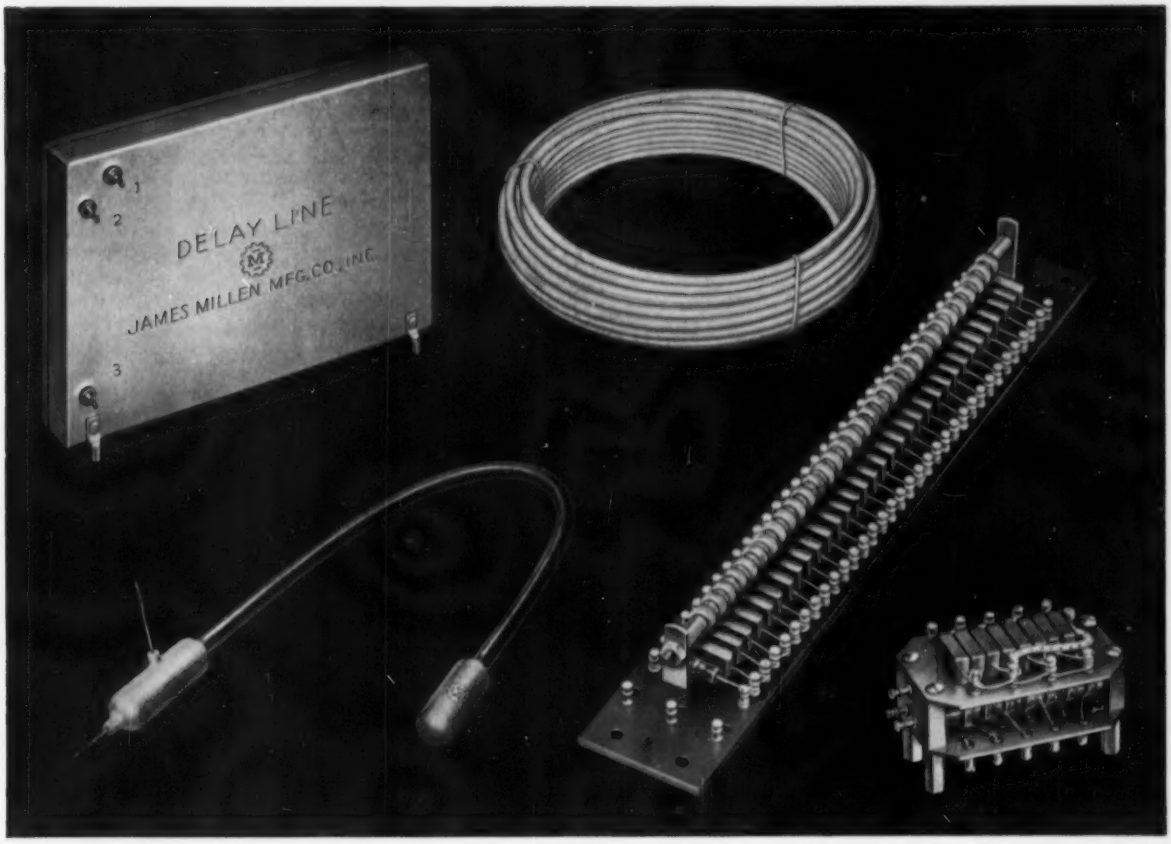
Technician wears nylon gloves while working on electron gun for retarding field oscillator tube. Gloves are necessary to avoid contamination

ELECTRONS are fired through a nozzle into a small cavity and toward a repeller located within the cavity in a new tube developed at Ohio State University. The repeller field makes the electrons bunch and drift back towards the nozzle, reacting with an alternating electric field as they do so.

As bunches of electrons return to the nozzle at the proper time intervals, oscillations are sustained. Power output is taken from the repeller, which is used as a coupling

Earth Satellite Uses Minitrack Transmitter

Small transmitter held in hand of J. T. Mengel, NRL scientist, is enclosed in gold-plated aluminum container. Signals from the transmitter will be used to track the unmanned earth satellite of which a model is shown at right. A. V. Astin, National Bureau of Standards discusses Project Vanguard with Capt. B. G. Wade of Office of Naval Research



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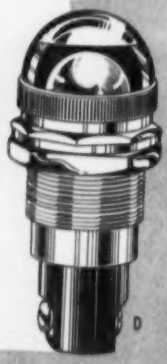

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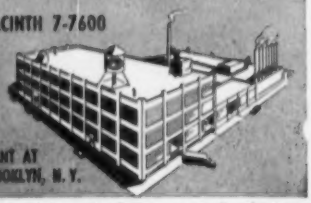

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device into an output waveguide.

Although the first developmental tubes, sponsored at Ohio State by the Air Force, operated in the range from 3 to 6 kmc, the present tubes can be used successfully at 70 kmc or, with reduced power, at 100 kmc (3 mm).

► **Production**—According to Prof. E. Milton Boone, supervisor of the project, the tube will be easy and inexpensive to manufacture, it is tunable and operates at lower voltage and with higher power output than commercially available reflex klystrons.

Internal dimensions of the cavity for a retarding-field oscillator operating at 6 mm are about a tenth of an inch wide and 25 thousandths of an inch high. Assembly of a tube with aid of a low-power binocular microscope is necessary. A number of noble metals are used in the construction, including gold solder. Sapphires are employed as bearings.

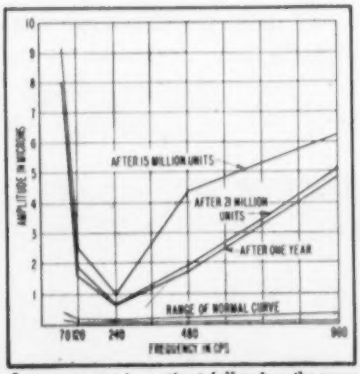
Air Navigation Receiver Used By Navy

Adoption of VORTAC system upon recommendation of Air Coordinating Committee requires engineering new equipment to combine VOR with TACAN for commercial aircraft use. Airborne TACAN receiver shown, developed by Federal Telecommunication Laboratories for military, gives essentially same cockpit display as equipment in design.

Pallometer Determines Patient Sensitivity

THE LARGE myelinated nerve fibers are thought to carry vibratory appreciation, light-touch sensibility and position sense. Velocity of the impulse has been shown to be rapid. There appears to be evidence that these fibers are affected earliest in certain types of neuropathy.

In 1941, experiments using a modified tuning fork showed variations among patients for measurements of duration of vibratory sensation. It was found that vibratory appreciation was invariably intact in patients with psychoneuroses of the combat fatigue



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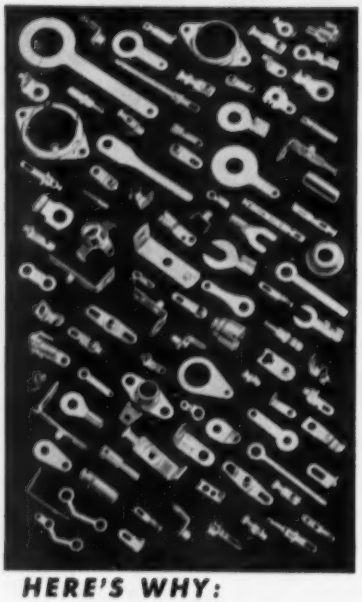

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Position of operator and patient's fingertips (left) in test position. Threshold of feeling is measured in microns

type, and suggested that this technique be used to distinguish between patients with psychoneuroses and those with organic injury to the brain.

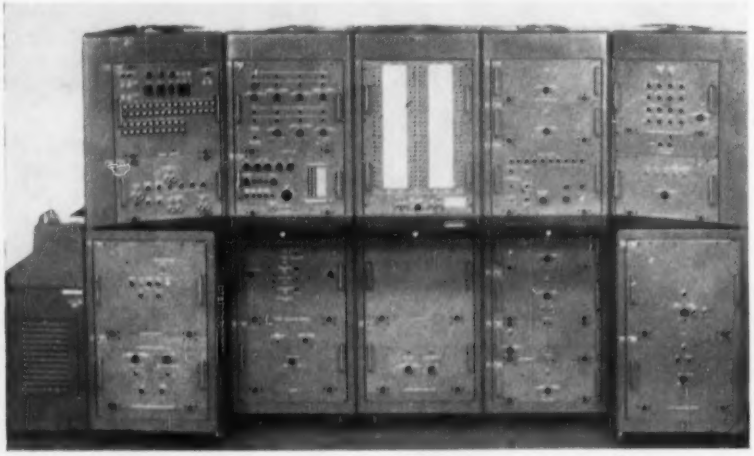
▶ **Improved Method**—An electronic circuit and electromagnetic vibrator as shown in the block diagram are the subject of a patent held by Dr. Samuel Goldblatt of Cincinnati. This device replaces the tuning fork of earlier experiments and its function is self-explanatory. It makes possible more exact determinations of the threshold of acuity at various frequencies, whereas a multiplicity of tuning forks would otherwise be required.

The curves show reactions of a

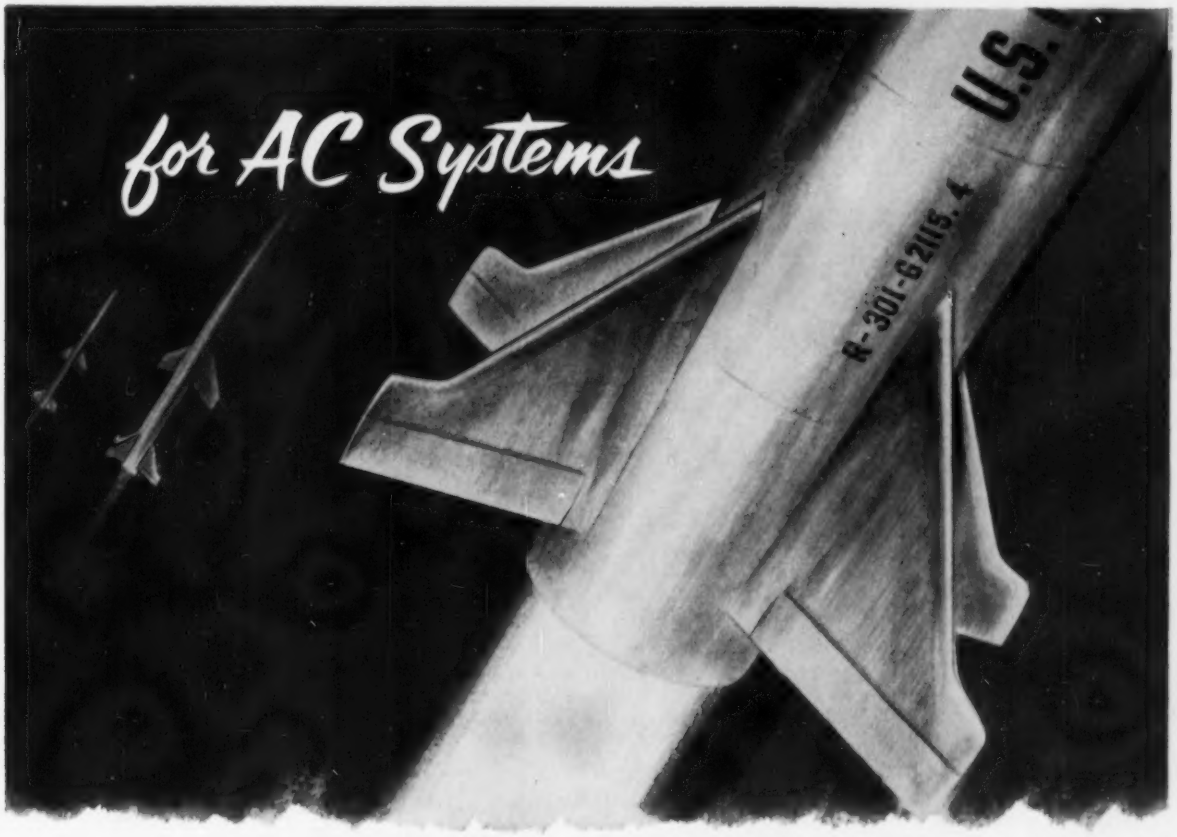
Manipulator Sees With 3-D TV

Exhibited for the first time at the Atomic Industrial Forum in Chicago was Farnsworth's three-dimensional closed-circuit television system designed for observation of remotely handled radioactive equipment. The dual camera system (upper left) projects its images on the screen (right) and the operator, wearing Polaroid glasses gains a clear picture of his objective. Electromechanical manipulators designed by Borg-Warner (operated at right) control the movement of claws (left)

Tester Simulates Missile Launching



Designed by Electronic Engineering Co. for testing Falcon missiles at Hughes Aircraft, the equipment shown checks out the sequence of electromechanical and electronic functions. If a test is unsatisfactory, the sequence is interrupted. A punch card shows results of final checkout



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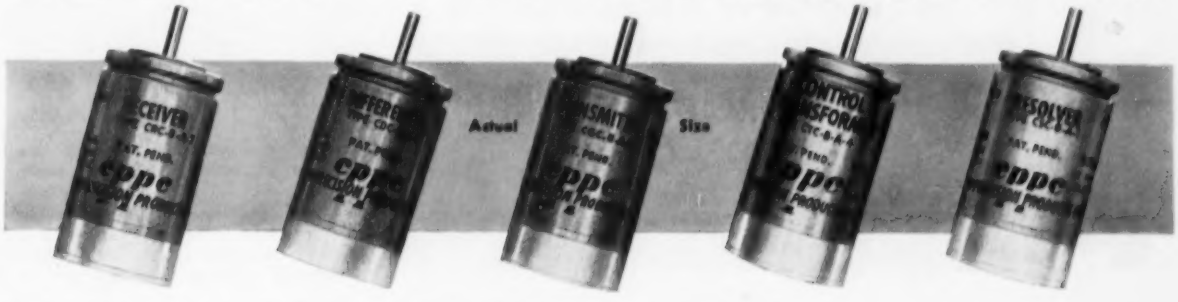
STANDARD UNITS		ROTOR						STATOR						IMPEDANCE								
SYNCHRO FUNCTION	CPPC TYPE	Input V400cy	Input Amps	Input Watts	Ohms (DC)	Output Rotor	Sensitivity (MV/deg.)	Output Volts	Sensitivity (MV/deg.)	Input Volts	Input Amps	Input Watts	Ohms (DC)	Zro	Zso	Zrss	Phase B-S	Shift S-R	Nulls (MV)	Possible Error	Spd	Length in inches
Torque Transmitter	CGC-8-A-7	26.0	.100	.5	37	—	—	11.8	200	—	—	—	12	54+j260	12+j45	76.4+j19.6	8°	—	30	7′	14′	1.240
Control Transformer	CTC-8-A-1	26.0	.050	.25	143	24	410	11.8	200	11.8	.090	.23	25	220+j740	28+j110	246+j60		8.5°	30	7′	14′	1.240
Control Transformer	CTC-8-A-4	—	—	—	381	24	410	—	—	11.8	.037	.09	60	508+j1680	67+j270	640+j190	—	9.2°	30	7′	14′	1.240
Control Differential	CDC-8-A-1	—	—	—	36	11.8	200	—	—	11.8	.085	.21	25	38+j122	27+j120	48.6+j13.8	—	9°	30	7′	14′	1.240
Electrical Resolver	CSC-8-A-1	26.0	.039	.43	230	23.2	400	10.6	180	11.8	.084	.27	27	280+j600	38+j136	70+j136	20°	11°	30	7′	14′	1.240
Torque Receiver	CRC-8-A-1	26.0	.100	.50	37	—	—	11.8	200	—	—	—	12	54+j260	12+j45	85.1+j20.4	8°	—	30	30′	30′	1.240



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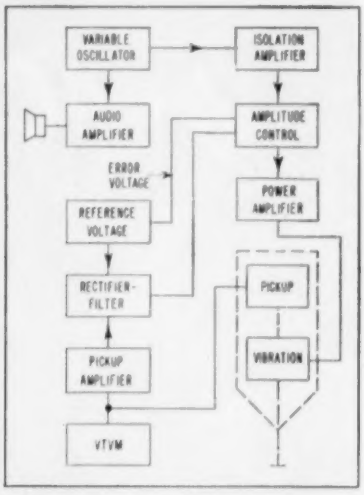


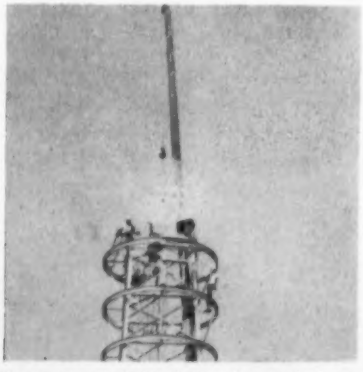
Block diagram of Goldblatt's pallometer

patient suffering from meningovascular syphilis. Initial depressed values of acuity are followed by improvement following penicillin therapy. Completely normal values are expected in 3 to 5 years following completion of treatment.

Components In Radiation Field

RADIATION damage to electronic equipment may result from direct or indirect effects. For example, on being placed in a radiation field, a capacitor will exhibit an in-

Modern Telephone Pole



Ten-foot parabola being lowered into place atop 200-foot microwave tower shows trend of toll circuits from wire lines to radio links. Installation is being made in Fort Wayne, Indiana for subsidiary of General Telephone System, second largest system in the United States

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SPECIFICATIONS

RANGE:	0.01 μμf to 12 μf	FREQUENCY:	1,000 cps
ACCURACY:	2%, 0.1 μμf to 12 μf; 5%, 0.01 μμf to 0.1 μμf	METER:	Logarithmic scale
		SIZE:	13½" x 7½" x 7"

BALLANTINE LABORATORIES, INC.

100 FANNY ROAD, BOONTON, NEW JERSEY

creased dissipation factor, dark current will increase in a photocell and the resistance of a resistor will fall.

An example of indirect radiation damage is that caused a capacitor when heating occurs from increased leakage.

► **Five Rules**—An engineer can evaluate his problem somewhat more easily by making the following assumptions:

(1) Total dose at which a component deteriorates is relatively insensitive to the dose rate.

(2) Adequate interpretation of damage does not require a knowledge of the energy spectrum of the radiation.

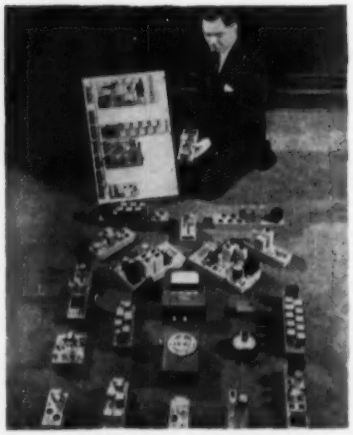
(3) Components operating satisfactorily in an environment should suffer no deterioration in a less severe environment.

(4) Most rate effects arise from gamma radiation. These effects include ionization leakage and photoelectric effects such as photoconduction in transistors and resistors.

(5) One type of radiation dose does not nullify another. If a component survives gamma, fast neutron and slow neutron doses it will survive one of the constituent doses alone.

The entire air space around an

Plug-In Controls



Twenty-one standard building block components that may be grouped as desired, form control systems at lower cost than custom-fabricated assemblies. The Sparks-Withington equipment shown is being used in the oil industry, petrochemical plants and water-pumping stations

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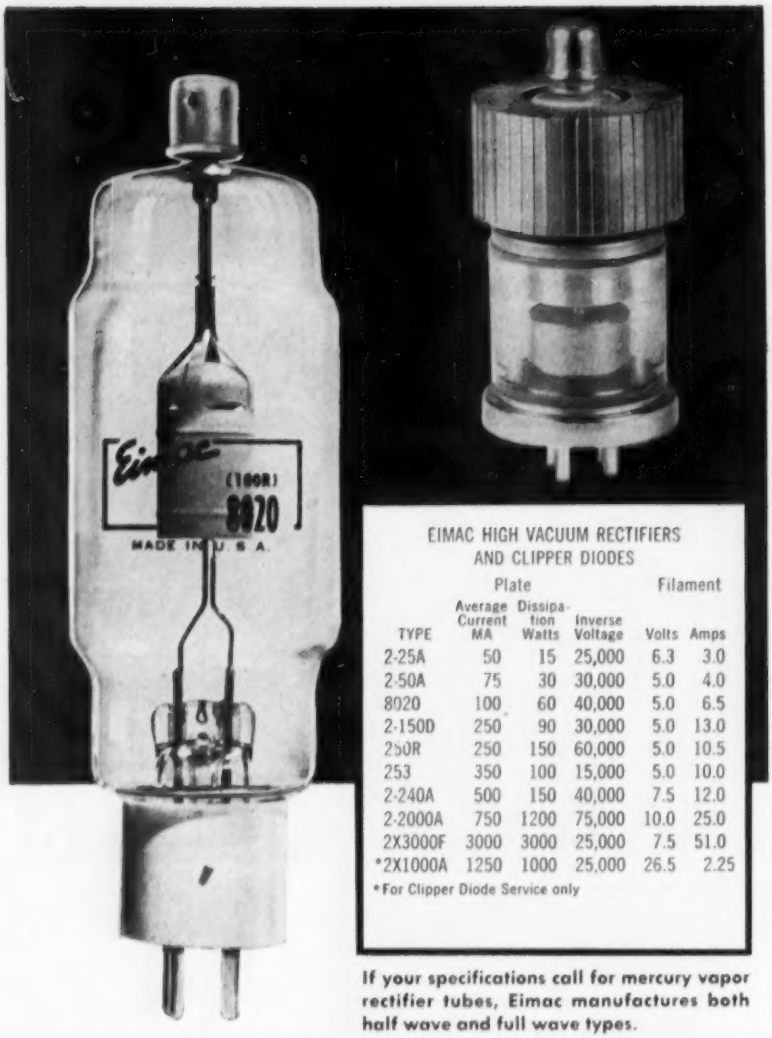

EIMAC HIGH VACUUM RECTIFIERS AND CLIPPER DIODES

TYPE	Plate: Average Current MA	Plate: Dissipation Watts	Plate: Inverse Voltage	Filament: Volts	Filament: Amps
2-25A	50	15	25,000	6.3	3.0
2-50A	75	30	30,000	5.0	4.0
8020	100	60	40,000	5.0	6.5
2-150D	250	90	30,000	5.0	13.0
250R	250	150	60,000	5.0	10.5
253	350	100	15,000	5.0	10.0
2-240A	500	150	40,000	7.5	12.0
2-2000A	750	1200	75,000	10.0	25.0
2X3000F	3000	3000	25,000	7.5	51.0
*2X1000A	1250	1000	25,000	26.5	2.25

*For Clipper Diode Service only

If your specifications call for mercury vapor rectifier tubes, Eimac manufactures both half wave and full wave types.

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electronic system in a radiation field behaves like an ionization chamber. Currents in the order of a few millimicroamperes flow between bare wires with a few volts difference of potential. Small nuclear batteries are formed by thermal-neutron induced beta decay in copper wire.

The abstract above is taken from a paper by R. D. Shelton of Admiral Corp. presented before the National Conference on Aeronautical Electronics.

Ebicon Sees In Dark

PROMISING to be 100 times more sensitive than present day tv camera tubes a new tube termed Ebicon from the initials of Electron Bombardment Induced Conductivity is presently under development at the research laboratories of Westinghouse.

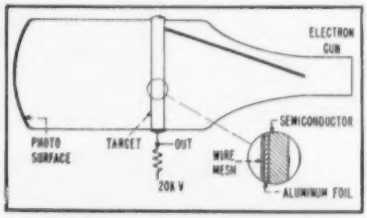
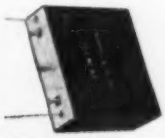


FIG. 1—Ebicon uses standard electron gun-deflection system of image-orthicon to charge semiconductor target

Figure 1 shows a schematic of the tube. It consists of a cesium-antimony photosurface on which the image is focused, a target consisting of a thin, fine-mesh screen to which is attached a layer of aluminum foil 1,000 angstrom thick and a layer of semiconductor material several microns thick and the standard electron-gun deflection system found in image-orthicons.

Operation is as follows: the image, focused on the photosurface, produces electrons that are accelerated to the target by approximately 20,000 volts. The electrons progress through the target and causes an avalanche effect to take place in the semiconductor. Since the semiconductor had previously been uniformly charged by the scanning electron beam, the electrons progressing through it discharge a minute segment. On reaching that seg-



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- for operations above 1 mc
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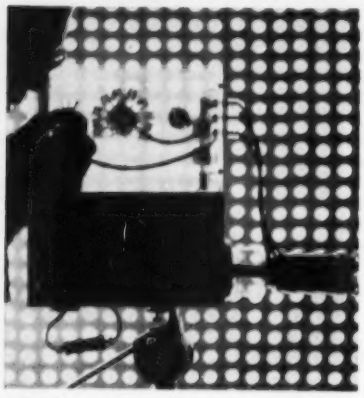
ment the scanning beam recharges the surface, generating a pulse in the output circuit.

► **Multiplier**—The unit is said to be capable of detecting light levels of 0.00005 ft-c. The use of a newly developed image multiplier tube may increase the Ebicon sensitivity to approximately 0.000001 ft-c.

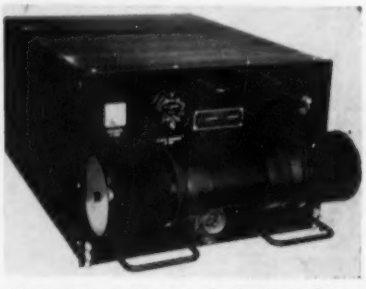


Ebicon, operating on electron-multiplication principle promises to be 100 times more sensitive than present tv cameras

The image multiplier of Fig. 2 may be used for either direct viewing or may be placed between the photosurface and target of the Ebicon, eliminating the phosphor screen used for direct viewing.

Operating principle of the image multiplier is based on the fact that electrons impinging on a thin film of potassium chloride deposited on a supporting thin mesh will cause approximately 10 electrons to be emitted from the opposite side. By

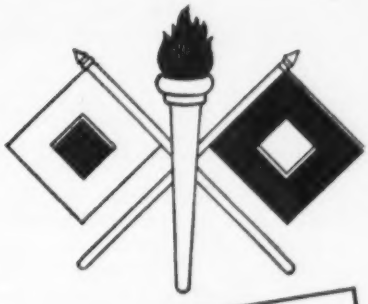
Airborne TV Reconnaissance

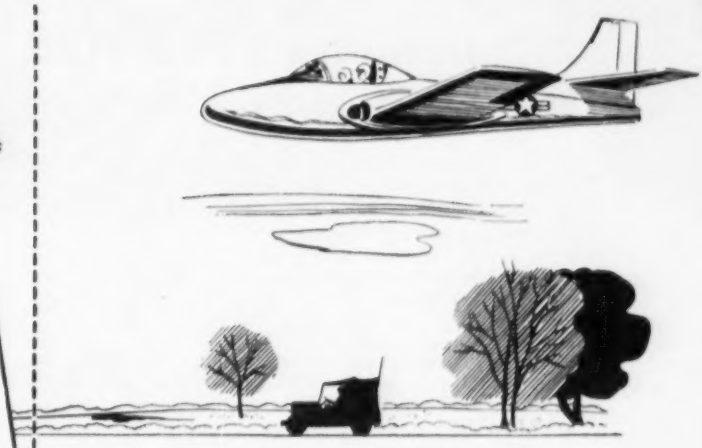


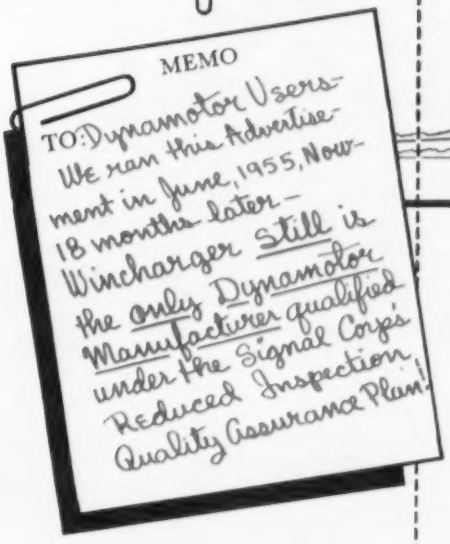
Transmitter used to send television observations from aircraft traveling at supersonic speeds

Winco dynamotors qualify

for Signal Corps Reduced Inspection Plan







The Wincharger Corporation's long history of producing dynamotors *equal to or better than the Acceptability Quality Level established by the government* has resulted in the Signal Corps' selection of Winco dynamotors for its Reduced Inspection Quality Assurance Plan.

As of this writing, *Wincharger is the only manufacturer of dynamotors qualified under RIQAP.* Only those suppliers who have consistently furnished material of the highest quality level and who maintain quality control and inspection methods and procedures acceptable to the Signal Corps are considered for this honor.

This new Signal Corps plan places more responsibility for maintenance of quality on the manufacturer by reducing the amount of government inspection. It is an honor inspection program.

What does Wincharger qualification for RIQAP mean to you — further evidence that you can depend on Winco Products.

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- Molded Melamine rotor covering entire contact circle provides high voltage breakdown between decks.
- Outstanding moisture, humidity, and salt-spray resistance through use of passivated stainless steel, nickel-plated brass, Steatite, Nylon, molded Melamine, and Silicone-base glass-fibre laminate parts.
- Adjustable stainless steel stops—easily positioned.
- Uniformly high quality—cost-reducing mechanized production and assembly.
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MOUNTING—Single or 2-hole, with non-turn tang.
OPERATING VOLTAGE—to 1500 volts.
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BREAKING CURRENT—5 amp @ 125 V. ac.
CARRYING CURRENT—15 amp.

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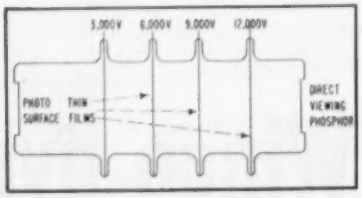

FIG. 2—Image-multiplier tube has gain of 100,000 using properties of thin films. Electrons are focused by magnetic field about tube

placing four of these films behind each other a gain of 10^4 in number of electrons may be obtained.

A magnetic field is used to focus the electrons as they travel between the films.

Quieting Polar Relays

SQUARE-WAVE voltage normally transmitted by the armature of a polarized relay reproducing telegraph signals is rich in harmonics extending well into the radio-frequency range.

Fourier analysis of a 25-cps square-wave signal of 80 volts peak (that is, a continuously repeated polar signal of alternate 1-unit marks and 1-unit spaces at 50 bauds from a telegraph battery of 80-0-80 volts), shows that this signal contains voltages of approximately 85 to 5,000 microvolts in the frequency band 30 megacycles to 500 kilocycles.

When telegraph and radio equip-

Magnetic Devices Replace Tubes

Miniature saturable reactors comprising wire-wound magnetic cores encased in resin and used with carriers in the range from 1 to 10 mc can often replace electron tubes in various circuits. Called Ferristors by Berkeley Div. of Beckman Instruments, some are supplied fixed magnetic bias by adjustable magnets. Others can be used with fixed d-c bias

THE ONE UNIVERSAL METER

MICROVOLTS TO KILOVOLT

MODEL 203 · 100 UV TO 1000 V · 100 UUA TO 100 MA · USE AS 80 DB DC AMPLIFIER

The **KAY LAB** Model **203** is a combination DC microvolt-ammeter and amplifier. It provides an exceptionally wide range of measurements. Fifteen voltage ranges cover from 100 microvolts full scale to 1000 volts full scale, with 100 megohms input impedance. Ten current ranges cover from 100 micro-microamperes full scale to 100 milliamperes full scale. As little as 10 microvolts or 10 micro-microamperes may be measured with accuracy. The uncluttered zero-center meter face instantly indicates polarity on a mirrored scale. When used as a DC amplifier, the instrument features exceptionally low drift with high gain, very high input impedance and low output impedance. Gains up to 80 db with less than 10 microvolts drift may be obtained. The Model **203** utilizes **KAY LAB's** unique chopper stabilized circuit to provide high sensitivity with previously unobtainable drift-free stability and high input impedance.

APPLICATIONS: Electronic, medical, geophysical, chemical, metallurgical research and development . . . transistor production and circuit design . . . thermocouple calibration . . . null detector . . . recorder driver amplifier . . . and as a general purpose laboratory instrument wherever dc voltages and currents are measured or amplified.

SPECIFICATIONS

Voltage Range (full scale)	100μv to 1000v
Current Range (full scale)	100$\mu\mu$a to 100 ma
Input Impedance	10 megohms below 10 mv, 30 megohms at 30mv, 100 megohms above 30mv
Impedance Accuracy	±1.5%
Accuracy on All Ranges	±3% of full scale
Maximum Gain as Amplifier	80 db ±1.5%
Output Rating	1v across 1000Ω
Output Impedance	less than 5Ω
Drift (after 15 min. warmup)	10μv equivalent input
Price	$550.00

Rack Mounting available as Model 203R

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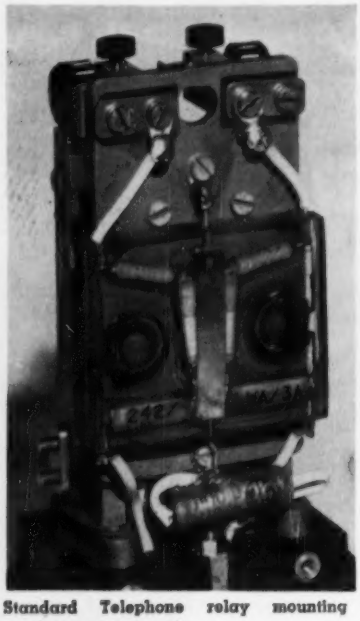


Standard Telephone relay mounting single suppressor unit

ments are used in proximity, it is desirable to suppress the radio frequencies without materially deteriorating the effective squareness of the signal as far as the telegraph equipment is concerned.

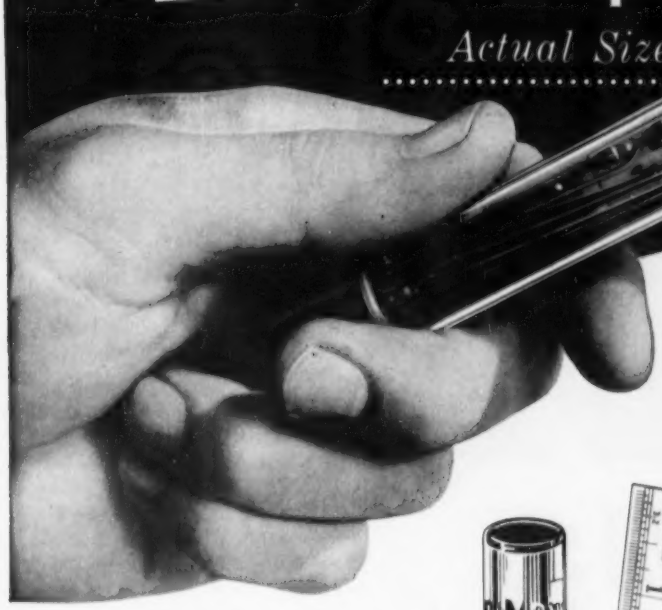
► **Circuit**—The basic circuit for such a suppressor developed by Standard Telephones and Cables, Limited, of London, England is a low-pass filter. The circuit shown in the drawing is intended primarily for relays transmitting polar (double-current) signals.

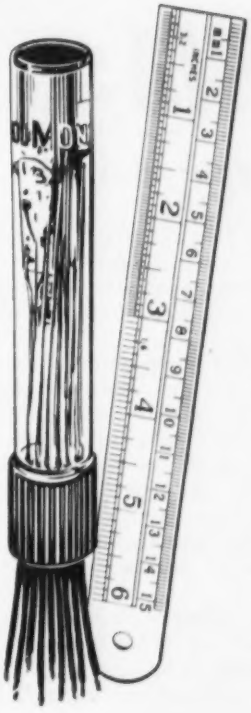
Resistors R_1 and R_2 reduce the surge currents that occur when capacitors C_1 and C_2 discharge through the relay contacts and which would otherwise cause contact sparking. The suppressor sup-

Single-unit encapsulated spark suppressor

NEW 10 STAGE 3/4" multiplier phototube

Actual Size





DU MONT Type K1382

In the new Type K1382, Du Mont offers the first ¾" multiplier phototube with the ruggedness of field equipment combined with the performance of a laboratory tube.

The average gain of the Type K1382 of 300,000 at 105 volts/stage exceeds that of many laboratory tubes, with no sacrifice in long-term stability for which Du Mont multiplier phototubes are noted.

In addition to its small size and superb operating characteristics, the Type K1382 is unusually rugged. This tube has been designed for the roughest service under the worst climatic conditions. The tube base is potted and all leads jacketed to permit operation under severest humidity without leakage between leads. **Laboratory performance** can be obtained from this tube even when it is being dropped as a probe into a drill hole far underground.

As in other Du Mont multiplier phototubes, the linear box-type dynode structure is used. This means optimum electron collection greatly improving signal-to-noise ratio. Also, long leakage paths minimize noise and dark current. Dark current is only 0.1 ua at 105 v/stage and 25°C.

The small size and excellent performance of the new Type 1382 mean an extra bonus to users in the geological surveying field where, for example, its extra gain permits much longer signal transmission from underground locations before signal level becomes too low to be useful. It should be exceptionally useful in medical physiological probing. Batteries of these tubes may be used for speedier diagnostic procedure. In addition, the small size will help greatly in the miniature and portable designs that can function at least as well as laboratory equipment.

CONDENSED SPECIFICATIONS

Average gain:	300,000 at 105 v/stage
Maximum dark current:	0.1 ua max. at 105 v/stage and 25°C
Photocathode sensitivity:	40 ua/ lumen
Average anode sensitivity:	12 a/lumen
Maximum outside diameter:	no greater than ¾"
Physical Characteristics:	potted base, jacketed leads

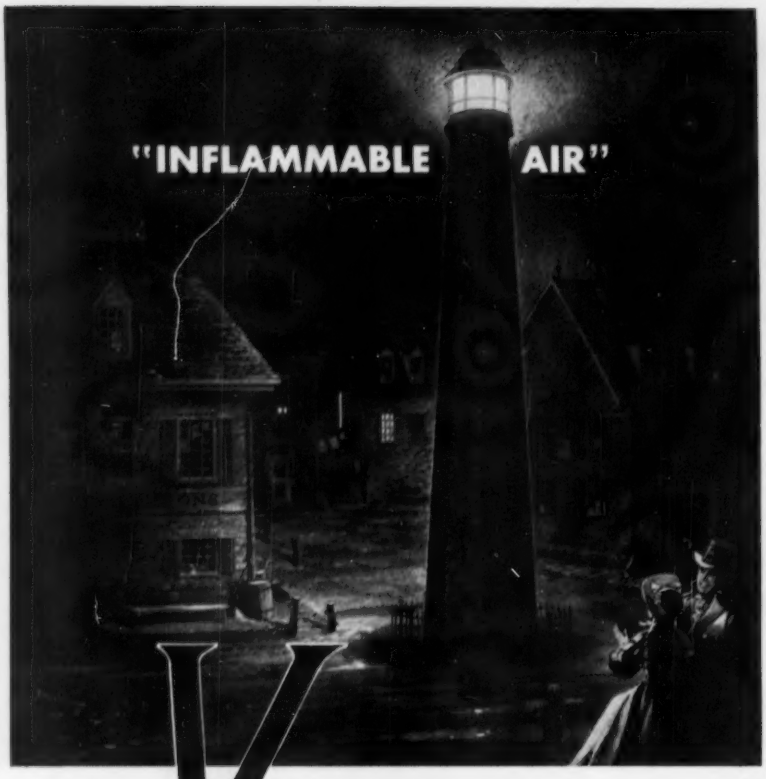
DU MONT®

For complete information write to:

Industrial Tube Sales Dept.

ALLEN B. DU MONT LABORATORIES, INC.

2 Main Ave., Clifton, New Jersey



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is still a plus for your Plant—

In 1803, a street lighthouse forty-feet high rose at 11th and Main Streets, Richmond. Atop it blazed a lamp burning what the inventor, Benjamin Henfrey, called "inflammable air." Though short lived, this was probably the world's first gas lamp post. And it lighted the way for today's vast use of gas by Virginia's growing industries.

Your new plant in Virginia can choose from natural gas . . . abundant, low-cost electricity . . . and limitless supplies of top grade coal. At your door are minerals ranging from easily quarried limestone to titanium . . . huge forest reserves of hard and soft wood . . . industrial farm crops, including peanuts, soy-beans, cotton, tobacco . . . and the nation's largest output of marine animal oils.

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For confidential facts about available sites in this land of friendly people, good living, and business-like government that *likes* business . . . write or call

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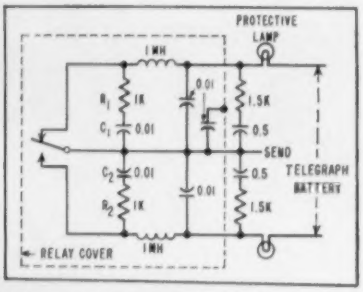
FACTS FAVOR VIRGINIA

plements the normal spark-quench circuit and is not intended to replace it. The spark-quench circuit itself will give some radio-interference suppression, chiefly at the lower end of the frequency spectrum.



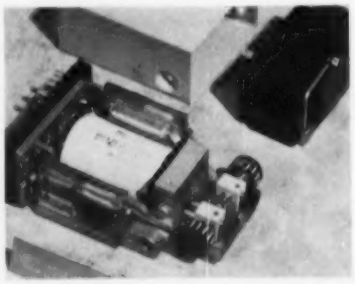
Schematic diagram of the spark suppressor circuit mounted on relay unit

The coils are Carbonyl dust-cored toroids and are capable of withstanding the full fault current should a ground or a short-circuit occur.

Components for the suppressor unit are encapsulated in Stantelene *V*, which is a plasticized expoxy-type resin, so as to form a rigid assembly whose overall dimensions can be controlled. The assembly can then be mounted and wired within the relay cover against the interfering source.

Two types of relays with two forms of suppressor are illustrated; one for relay in which all components for the suppressor are moulded into one unit and mounted at the back of the relay framework; the other is a relay in which space is more restricted and the components are therefore moulded into two equal units.

One unit is mounted on each side of the relay framework (the fifth



Relay fitted with suppressor formed in two units

What is SPECIAL about this ring?

This tiny ring is made of Alite AE-212, a sintered aluminum oxide formulated specifically for electronic applications. Because Alite possesses a unique combination of dielectric and physical properties, rings like this perform double duty in the construction of "ruggedized" electron tubes. Here they are used as insulating spacers, as well as forming structural elements of the tube envelope itself.

Alite maintains excellent dielectric characteristics throughout the entire spectrum, from power frequencies into the ultra high frequency range. In addition it has superior mechanical strength—a diamond-like hardness that gives it unusually high resistance to shock and vibration. Alite retains its physical properties at working temperatures well above 2000° F. By diamond wheel grinding, it can be finished to any required precision. Alite is vacuum-tight and is capable of being metalized and brazed to metal elements.

While these are properties which make Alite an ideal material for this particular application, there are other characteristics of Alite which indicate suitability for a wide range of uses, both mechanical and electrical. If you are designing or specifying in the mechanical, electronic or nucleonic fields, you'll want to be familiar with all the advantages Alite offers. For complete data, write for Bulletin A-7 today.

ALITE DIVISION

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356-E

True Hermetic Sealing
assures Maximum Stability
in AMPERITE
RELAYS and REGULATORS
Simplest • Most Compact • Most Economical

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MINIATURE

Thermostatic DELAY RELAYS
2 to 180 Seconds

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
- *SPST only* — normally open or normally closed.

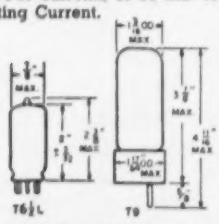
Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from —55° to +70° C. Heaters consume approximately 2 W. and may be operated continuously. The units are *most compact, rugged, explosion-proof, long-lived,* and — *inexpensive!*
TYPES: Standard Radio Octal, and 9-Pin Miniature

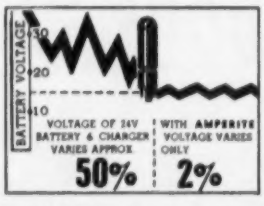
PROBLEM? Send for Bulletin No. TR-81

Also — **Amperite Differential Relays:** Used for *automatic overload, under-voltage or under-current protection.*

BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit ***automatically regulated*** at a definite value (for example, 0.5 amp.) ... For currents of 60 ma. to 5 amps. Operate on A.C., D.C., Pulsating Current.





T9 BULB

Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—55° to +90° C.), or humidity ... Rugged, light, compact, most inexpensive.

Write for 4-page Technical Bulletin No. AB-51

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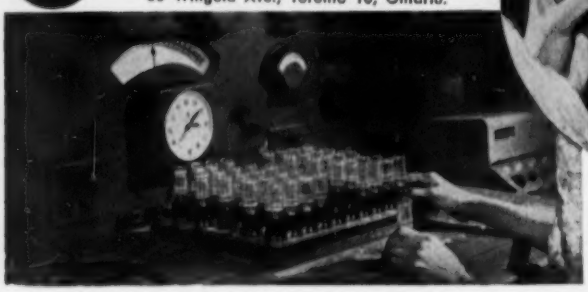
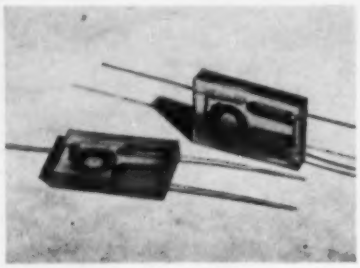


Individual inspection and double-checking assures top quality of **Amperite** products.

capacitor is wired on separately). With each type of suppressor, the units are within the relay covers and the rigidity of the mouldings and of the wires is sufficient to keep them in position without having to add fixing holes and screws.

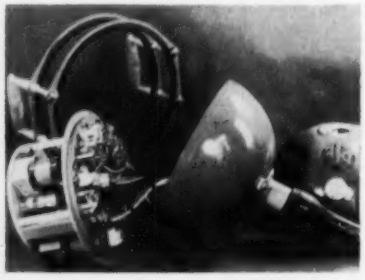

Two-unit suppressor equipment

These suppressors, when assembled within the relay framework, give a suppression of at least 50 decibels in the frequency range 0.5 to 30 mc when measured directly at the base of the relay; panel wiring and panel dust-covers give a further improvement in suppression.

Transitorized Dynamic Microphone

DESIGNED to increase the intelligibility of mobile communications, a dynamic microphone employing a transistor audio amplifier between microphone unit and cable

Underwater TV Camera


Present trend to nonsuited diving gives the diver unrestricted freedom but still leaves problem of direction and reporting unsolved. The Pye underwater television camera shown weighing 38 pounds in air and suitable to depths of 250 feet provides reporting means to observers on ship. Pickup tube is a vidicon type

UNI-RING offers a tremendous saving in installation time over any previous method of tapping or terminating shielded or coaxial cable. As the inner ring slides under the shielded braid, the tap wire is held between the braid and the outer ring. Single or multiple taps, from either the front or back of the connector, can be accommodated . . . A single crimp, using the same basic HYTOOLS used for installing HYRINGS, completes the uniform, secure, and insulated assembly.

The protecting nylon insulation extends beyond both ends of the UNI-RING, eliminating metal-to-metal contact and preventing harmful wire-chafing in tight locations. The UNI-RING is color-coded to indicate conductor sizes.

UNI-RING's one-piece design insures electrical integrity, prevents heating, and eliminates noises caused by isolated metal parts.

For samples and complete details, write: OMATON DIVISION

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PRECISION ACTION, SMALL SIZE, LOW COST are features of Bristol's new pressure switches for aircraft electrical circuits. Miniature size shown here.

New! Miniature pressure switch for aircraft use

Accurate, reliable, *repeatable* performance in any position and under MIL-spec environmental requirements is the design aim for Bristol's® new line of pressure switches.

Designed specifically to meet aircraft requirements, the switches are precision devices for switching electrical circuits in response to pressure changes in gases and liquids. They're available in both regular and miniature sizes.

Specially-designed capsular elements—All stainless steel or Ni-Span C, welded construction. Exclusive design assures maximum resistance to vibration.

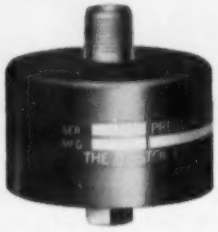
Absolute, gage, and differential pressure models available.

Hermetic sealing affords maximum protection. All exterior joints are metal-to-metal or metal-to-glass.

Outstanding over-range protection—Built to take high over-pressures without damage or loss of calibration.

Variety of mounting arrangements possible—Clamps, studs, or pressure fittings can be utilized to mount switch in any appropriate location.

Write for bulletin AV2004. The Bristol Company, 152 Bristol Road, Waterbury 20, Conn. 6.44



BRISTOL'S REGULAR-SIZE pressure switch. Both regular and miniature switches are made in absolute, gage, and differential pressure models.

TYPICAL SPECIFICATIONS

	Miniature Size	Regular Size
Pressure Setting:	Any pressure between 2 psi and 100 psi, absolute, gage, or differential, as specified	Any pressure between 5 psi and 150 psi, absolute, gage, or differential, as specified
Contact Ratings:	5 amp and 10 amp resistive at 30v d-c or 115v a-c	5 amp and 10 amp resistive at 30v d-c or 115v a-c
Weight (ounces):	1½	6
Size (inches):	1⅞ long 1 5/16 diam.	2⅝ long 2½ diam.
Ambient Range:	—65°F to 250°F	—65°F to 250°F
Vibration & Shock:	Designed to meet Spec. MIL E-5272A	Designed to meet Spec. MIL E-5272A

BRISTOL FINE PRECISION INSTRUMENTS FOR OVER 67 YEARS

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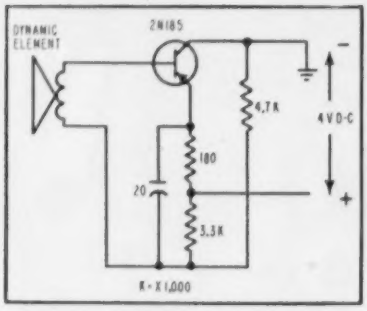


Circuit of the Motorola dynamic microphone using a single transistor

has recently been described at Wescon by A. A. Macdonald of Motorola.

The response characteristic of the dynamic element was shaped to eliminate undesired vehicle and wind noises. It is essentially flat from 300 to 4,000 cycles. The dynamic unit is relatively insensitive to hum fields.

Using the carbon-button current source for the transistor preamplifier, the unit becomes completely interchangeable with the conventional carbon microphone for which most communications transmitters are designed.

PERTINENT PATENTS

By Norman L. Chalfin
Hughes Aircraft Co.
Culver City, Calif.

Fluid flow, viscosity and determination of modulus can all be measured by equipment predominantly electronic in nature. Patents

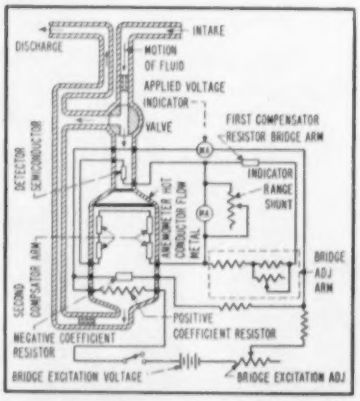
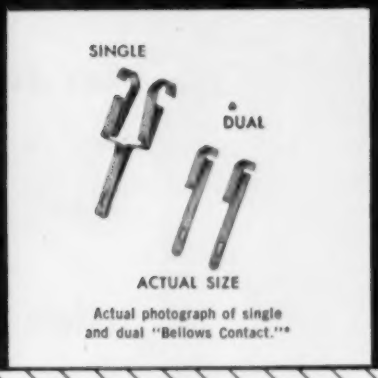
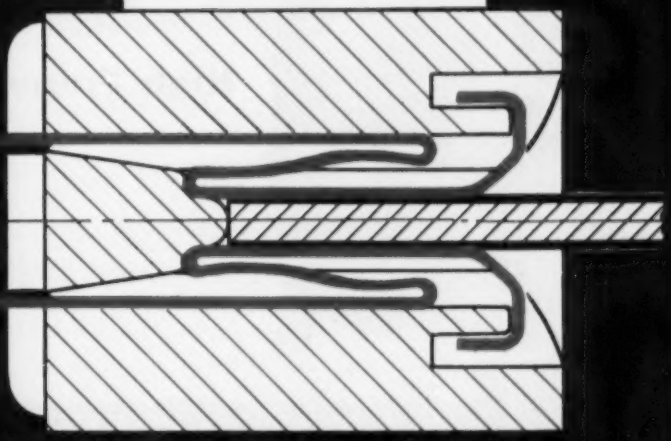


FIG. 1—Fluid-flow measurement depends upon hot-wire principle

"Bellows Action"* gives you 100% printed circuit board contact



Actual photograph of single and dual "Bellows Contact."*

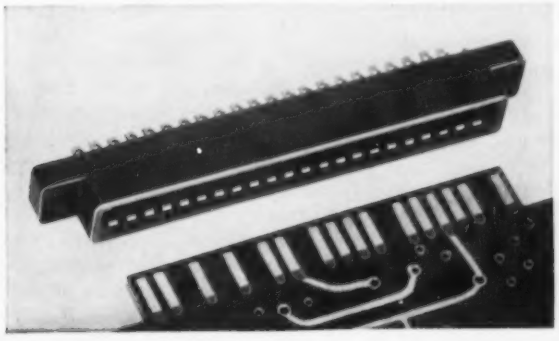


"Bellows Action Contact" cross-section shows printed circuit board inserted in contact.

Continental Connector "Bellows Action Contact"*

"Bellows" spring action grip clasps board firmly over 100% of printed circuit contact area. Gold-plated phosphor bronze spring retains tension, adjusts to oversized or undersized board while maintaining low contact resistance—less than 20 millivolts at 5 amps! On ⅛" board, for example, "Bellows Action" Contact grips .115" board as well as .135" board.

*Patent Pending



Printed Circuit connectors are available for ⅛", 3/32" and 1/16" boards . . . various molding compounds . . . 3 wiring styles . . . and 6 to 28 contacts.

Photo shows typical Continental Connector receptacles utilizing "Bellows Action Contacts." CONTACTS: 6, 10, 15, 18, 22, 28 contacts in single or double rows. WIRING STYLES: eyelet lug for soldering, wire wrap lugs, or 90° angle dip soldering direct to board. MOLDINGS: Mineral-filled Melamine and Plaskon reinforced (glass) Alkyd 440A. Other molding compounds on request.

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High Voltage

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High Frequency

Lapp's experience of 18 years of design and manufacture of gas-filled condensers is back of this precision-made unit and its promise of years of trouble-free duty. It is small in size and low in loss, offers high voltage and current ratings, high frequency limits, safety, puncture-proof operation and constant capacitance under temperature variation.

The entire electrical and mechanical assembly of the Lapp gas-filled condenser is supported by a top aluminum ring, the steel tank serving only as a support for this ring and as a leak-proof gas container. High-potential plates are carried on a rigid center stud which is supported by a top ceramic bowl. Grounded rotor plates are carried on ball bearings nearly the full tank diameter. This construction provides a grounded tuning shaft on variable models and makes possible efficient and complete water cooling for high current operation.

Models in four tank diameters, 7" to 18", are available, in variable or fixed capacitances, for duty up to 30,000mmf; in current ratings to 400 amps at 1mc; operating voltages to 80Kv peak. Write for Bulletin 302, with complete description and characteristics data. Lapp Insulator Co., Inc., Radio Specialties Division, 906 Sumner Street, Le Roy, N. Y.

Lapp

covering these techniques are described this month.

Fluid Flow

Moses G. Jacobson has invented an "Electrical System for Measuring the Rate of Motion of a Fluid". Patent 2,694,928 issued for this system is assigned to Mine Safety Appliances Co., Pittsburgh, Pa.

In Fig. 1 a circuit arrangement of this invention is shown as inporated in a fluid flow line.

With a Wheatstone bridge comprising a semiconductor detector, two compensating resistance arrangements and an adjustment arm, the inventor is able to measure fluid flow.

An anemometer or hot-wire flow meter through which fluid flow is measured has an enlarged bulb at

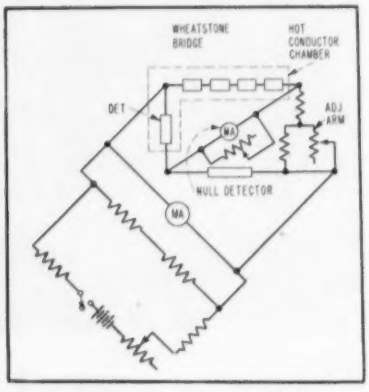
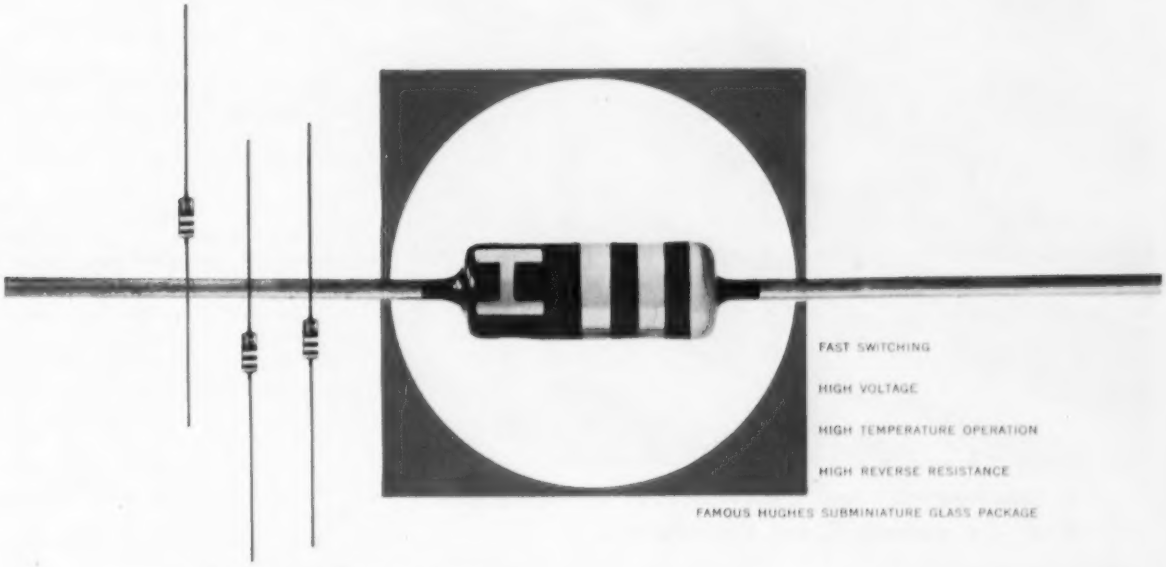


FIG. 2—Wheatstone bridge circuit used in flow meter

the intake. Here the semiconductor detector unit is housed. In an outlet chamber a group of four temperature-sensitive resistors is arranged.

These are called second compensators in Fig. 1. The first compensator is outside the chamber along with the bridge-balance adjustment. The four Wheatstone bridge arms are arranged as in Fig. 2. The detector has a negative-temperature coefficient and the four temperature - sensitive resistors forming an adjacent second leg of the bridge are likewise of a negative-temperature coefficient. The resistor shown as first compensating resistor keeps the zero adjustment constant against small drift



FAST SWITCHING

HIGH VOLTAGE

HIGH TEMPERATURE OPERATION

HIGH REVERSE RESISTANCE

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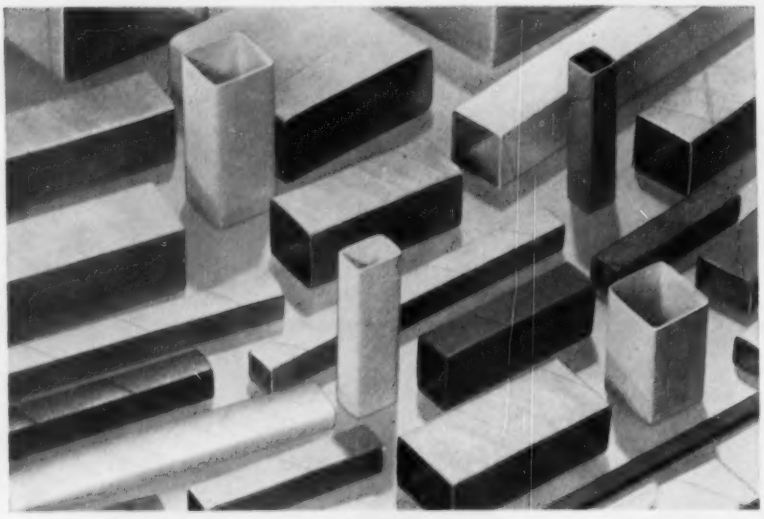

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in voltage and ambient temperature.

The fourth bridge arm comprises the bridge-balance adjust resistor network. These resistors are substantially unaffected by temperature.

By dependence on the cooling of a resistance such as in the detector and second compensator arms of the bridge an unbalance of the bridge is created that shows on the null detector meter.

By appropriate arrangement of the compensating resistors actual flow in cu ft per min may be determined and the null indicator calibrated. The system gives a continuous instantaneous indication of flow rate.

Other uses of the system are shown for control of fluid flow. The circuit is substantially the same and is shown in Fig. 3. A vane in the fluid flow path moves a capacitor to change the power output of an amplifier (presumably the increase in capacitance couples more battery source energy to the bridge) to permit a greater current to flow to the bridge null indicator and permit greater indication range.

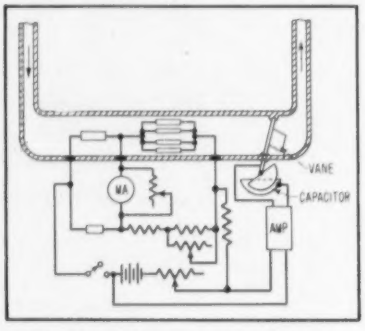


FIG. 3—Vane controlled by flow increases indication range

Measuring Viscosity

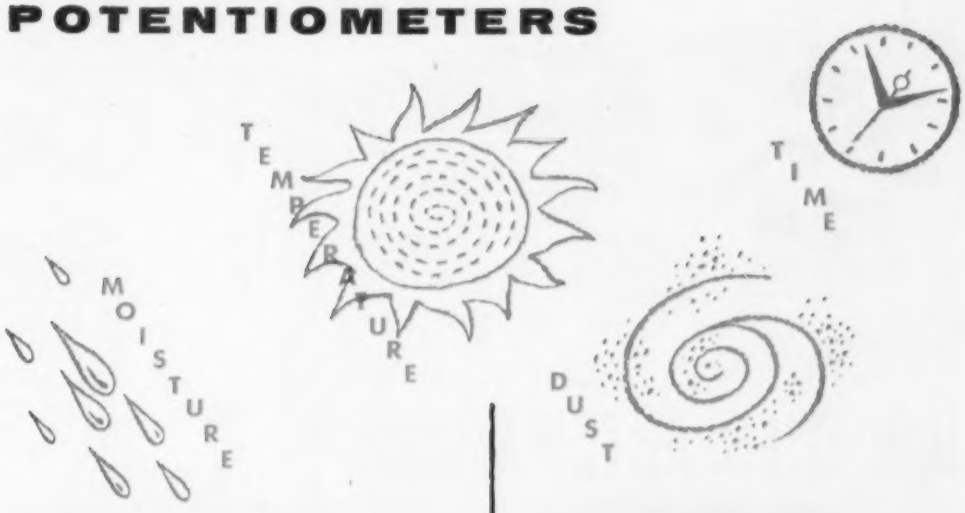
In patent 2,707,391 issued to H. J. McSkimin means of testing viscous liquids is described. The invention is assigned to the Bell Telephone Laboratories, Inc., New York, N. Y.

The particular properties of viscous liquids that the invention is designed to test include viscosity, shear impedance and shear stiffness.

When a shearing stress of sinu-

POTPOT

POTENTIOMETERS



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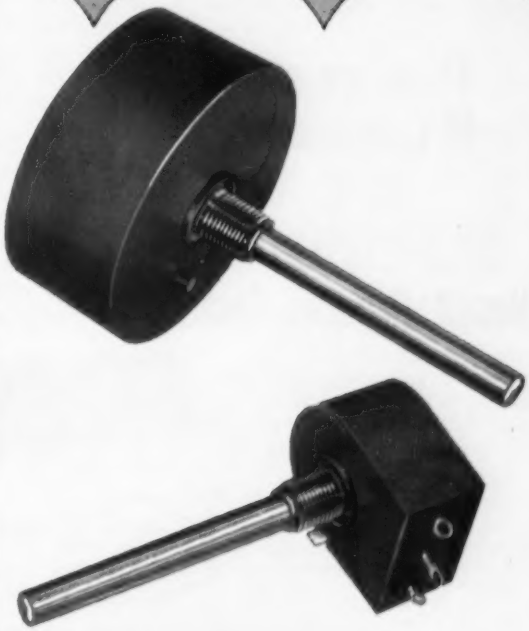

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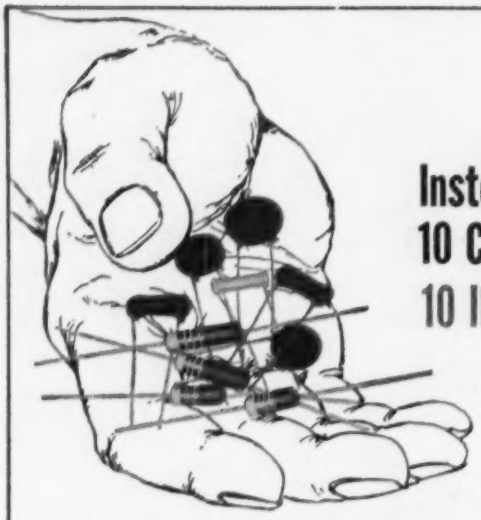

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soidal variation is set up in a viscous fluid a corresponding shearing strain is developed in the fluid.

To test these properties a quartz piezoelectric cylinder is inserted in the liquid as shown in Fig. 4. The quartz cylinder has a nominally resonant frequency of about 100 kc and has pairs of gold electrodes

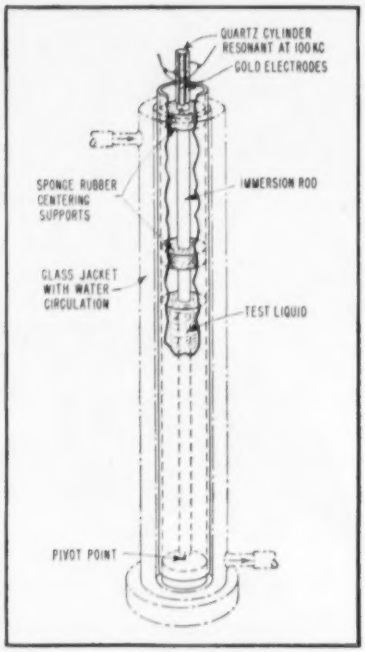

FIG. 4—Quartz cylinder driven at 100 kc tests viscosity

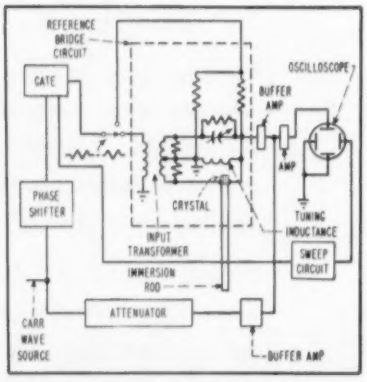

FIG. 5—Bridge circuit used in ultrasonic viscosity measurement

connected across the y and z axes of the crystal.

The piezoelectric crystal is soldered to a rod and the rod immersed in the center of the test fluid.

In Fig. 5 the circuit for measuring the viscosity of the liquid is

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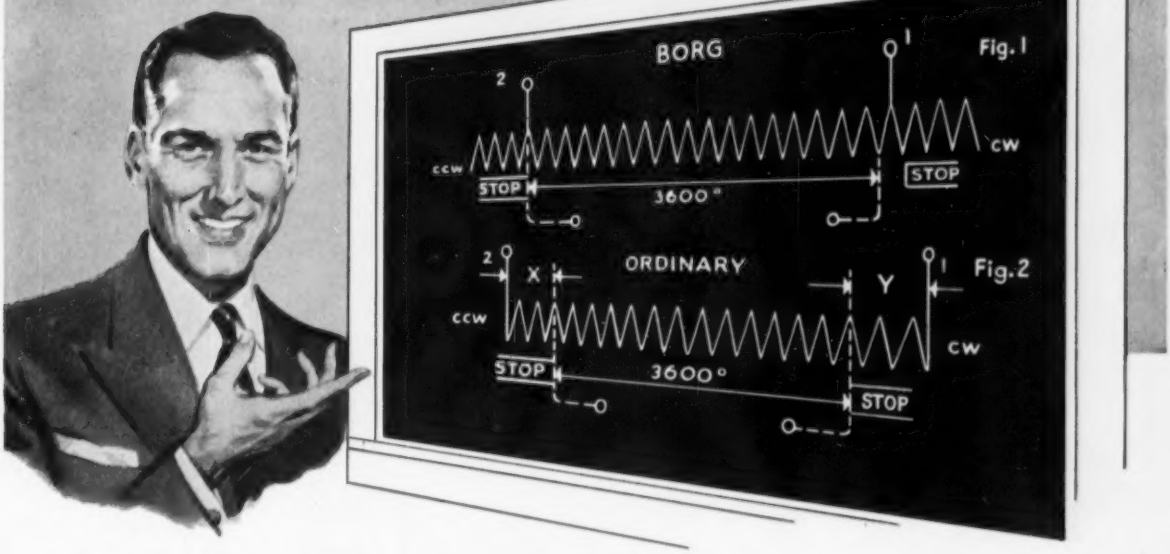

Borg Micropots Reduce Assembly Costs With Simplified Trimming of Borg Independent Linearity

All Borg independent linearity MICROPOT Potentiometers may be trimmed at one end only. They will then produce an output voltage within the linearity tolerance of the potentiometer.

BORG MICROPOTS

This is readily illustrated in Figure 1, on the blackboard. The mechanical stops in all Borg MICROPOT Potentiometers with independent linearity, are set beyond the position of each terminal 1 and 2. This allows the contact to travel to the last active turn at either end of the winding. Thus, by positioning the contact at one end point, trimming of that end is not required.

ORDINARY POTENTIOMETERS

Note the mechanical stops in Figure 2. This is an ordinary potentiometer. The mechanical stops are set to prevent the contact from reaching the last active turn, causing "end resistances" X and Y, at either end. Both resistances X and Y must be trimmed to produce voltage outputs within the linearity tolerance of the potentiometer.

TRIMMING COST

The fact that, in Borg MICROPOT Potentiometers, one end can be set up without trimming eliminates the selection of fixed trimming resistors for that end, as well as the time for selection and installation required by ordinary potentiometers.

The maximum portion of the total resistance at the opposite end that would require trimming in Borg MICROPOT Potentiometers is 4%. This is 20% less than in ordinary potentiometers, which substantially reduces the selection of fixed trimming resistors required for use with higher linearity potentiometers.

Lower linearity tolerances may require no trimming whatsoever at either end.

POTENTIOMETER APPLICATIONS

Definitions of potentiometer parameters vary from manufacturer to manufacturer, thus causing misconception to the user. A set of tentative standard definitions has been adapted by RETMA and all Borg MICROPOT Potentiometer tolerances are written for interpretation under these definitions.

The "Trimming Costs" economy in potentiometer application is a typical example of the savings, and in many cases superior performance, achieved through a clear understanding of manufacturing specifications and user requirements.

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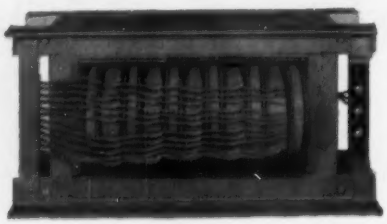

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Transformer shown above has a range of 5 to 2000 cycles, a capacity of 3.6 KW at 60 cycles, and high voltage windings. Illustration shows sandwiching of the high voltage coils between secondary windings. Available from 2 to 15 KW and up to 10 KV in dry type transformer.

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shown. The crystal is one leg of a bridge. The second and third legs are two resistors and the fourth leg a variable capacitor in parallel with a resistance.

A carrier source is applied to the bridge input transformer through a phase shifter and a gate circuit. The gate circuit serves to modulate the carrier so that the applied signal is a series of bursts as indicated in Fig. 6A. The gating circuit also synchronizes a horizontal sweep circuit in an oscilloscope.

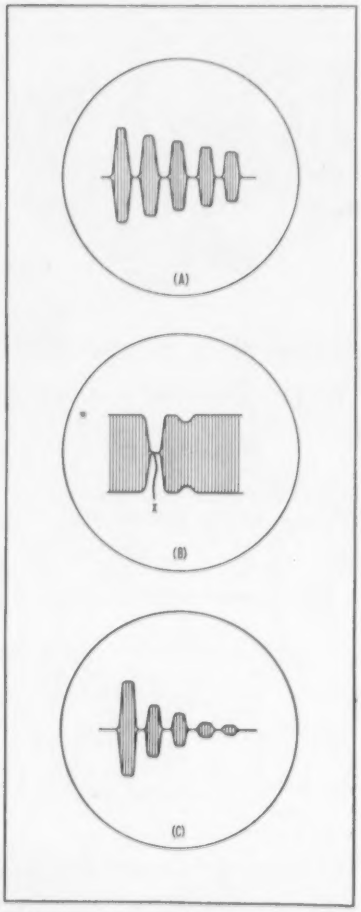

FIG. 6—Applied signal (A) combination of carrier and modulated wave balanced against first reflected wave (B) and attenuator branches disconnected, unit in test liquid (C)

A tuning inductance is connected across a diagonal of the bridge for adjustment. The diagonal appears between the junction of the vibratory crystal unit with

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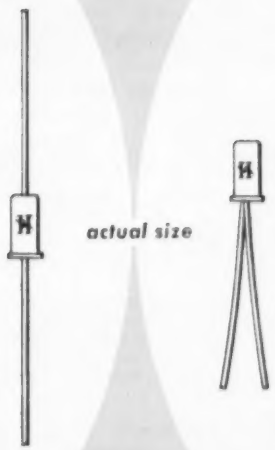

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Two types are provided to allow a choice of mounting: a two wire single ended type identical in size and physically interchangeable in mounting systems developed for the widely used IN200 series of alloy junction diodes; and an axial lead type* for automation, printed circuit board or terminal board assemblies. Both types have exceptionally good stability, are highly efficient (approximately 99%) and can operate in ambients ranging from −65°C to +175°C.

Type	Max. Recurrent Inverse Working Voltage — e_b (Volts)	Min. Zener (breakdown) Voltage — E_z (Volts) (Note 1)	Max. RMS Voltage (Volts)	25°C Ambient Max. Avg. Forward Current — I_o (Milliamps.)	Max. Avg. Forward Voltage at I_o = 500 mA (Volts)	125°C Ambient Max. Avg. Forward Current (Milliamps.)
HMP1 HMP1A*	50	70	35	500	1	250
HMP2 HMP2A*	100	125	70	500	1	250
HMP3 HMP3A*	200	250	140	500	1	250
HMP4 HMP4A*	300	375	210	500	1	200
HMP5 HMP5A*	400	500	280	500	1	200

Note 1 — Measured at a reverse current (I_z) of 0.1 mA
Note 2 — Derate to 0 forward current at 175°C Ambient
Note 3 — Cathode is electrically connected to the case
* — Axial lead types

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Voltage Derating at 150°C.	none
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the adjustable capacitor leg of the bridge and ground. The modulated carrier may be applied to this junction directly instead of through the transformer to make adjustments and tests.

The bridge output is applied through a buffer and another amplifier to the vertical deflection system of the oscilloscope.

In operation, the system is first adjusted to balance the bridge with respect to the impedance of the vibratory crystal unit at the operating frequency. The phase and attenuator adjustments are made to produce an initial signal condition as shown in Fig. 6A.

Figure 6B illustrates the waveform observed by the combination of the unmodulated wave from the carrier and the modulated wave superimposed and balanced against the first reflected wave.

With the vibratory unit inserted in the test liquid when the carrier wave source and attenuator branches are disconnected, the pattern observed is as shown in Fig. 6C. With the branches connected the waves of Fig. 6B are obtained.

The adjustment of the circuit is made to obtain a thin line x (shown in Fig. 6B) when the carrier and first reflected wave are balanced against each other.

From the readings a value Z of the loading impedance of the vibrating rod is obtained

$$Z = \frac{p v_o a}{4l} (\Delta A + \Delta B)$$

where p = density of rod material
V_o = torsional wave velocity of free rod.
a = radius of rod
l = length of rod in test liquid
ΔA = change of attenuation to establish balance
ΔB = phase shift to establish balance

The results from a single reading give shear viscosity and stiffness viscosity by utilizing the resultant Z correlated in terms of the density of the liquid according to formulas defined in the patent disclosure.

Determining Modulus

An invention using pulse-sonic techniques has been made by S. R. Rich in a "Modulus Determining System", patent 2,706,906. The in-

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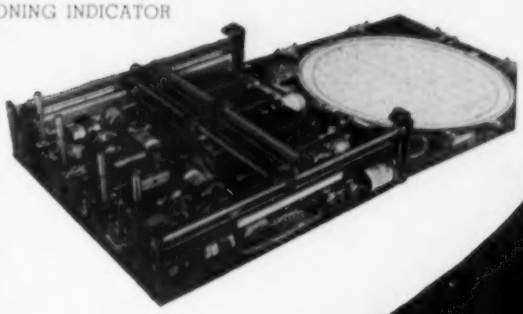
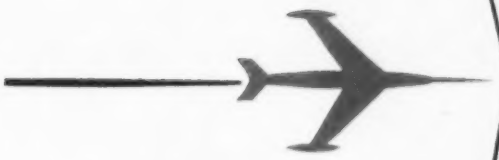
PILOT'S DEAD RECKONING INDICATOR





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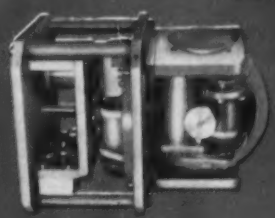

Aircraft All Attitude Indicator

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vention is assigned to Magnetic Amplifier Corp., Waltham, Mass.

The invention proposes a system for automatic measurement of the velocity of propagation of compressional sound waves in solid materials of any shape or size. The shortest measured pulse propagation time over the known distance yields the velocity of compussional sound waves in the material. The square of this observed velocity times the known density of the material equals Young's modulus.

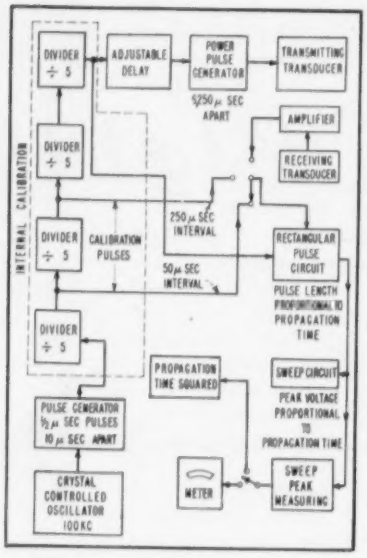

FIG. 7—Block diagram of the Young's modulus-determining system

A circuit block diagram of the measuring system of the invention is shown in Fig. 7.

Crystal controlled ½ microsecond pulses are generated at 100 kc and divided down to ½ microsecond pulses at 160 pps that drive a transmitting transduced to excite the measured item. A detector receives a compressional wave train from the measured item to produce a pulse envelope resembling a ringing effect.

Propagation time and pulse length are measured and compared to the driving signal to give a measure of the modulus of elasticity of the medium. By applying the driving pulse at a predetermined point and detecting the propagation of the pulse through the medium, anisotropy of even soft materials may be measured.

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DC SOLAVOLT, *shown partly disassembled here, has major components identified. It is designed for relay-rack mounting on a standard, 19" frame or for bench use. Removable handles, for convenience when portability for bench use is desired, are available as accessory equipment.*

Unique combination of components in adjustable "DC Solavolt" regulated power supply reduces conventional size, weight, and cost

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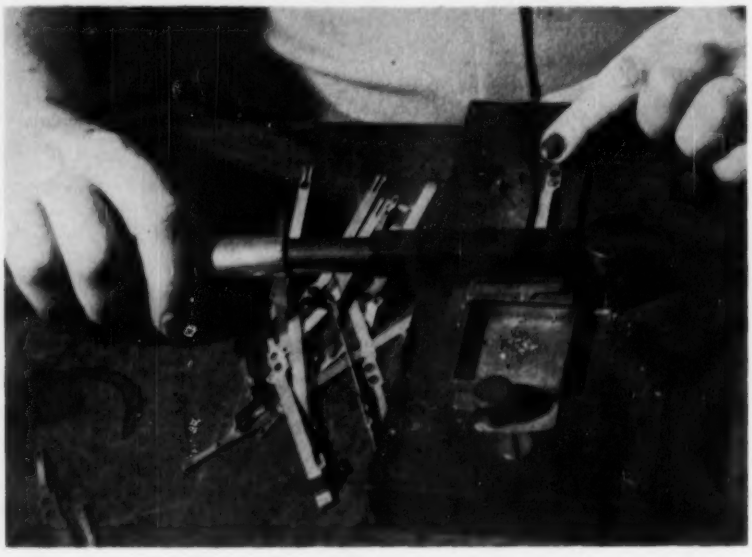
Production Techniques

Edited by JOHN MARKUS

Salvaging Platinum from Rejected Contact Springs



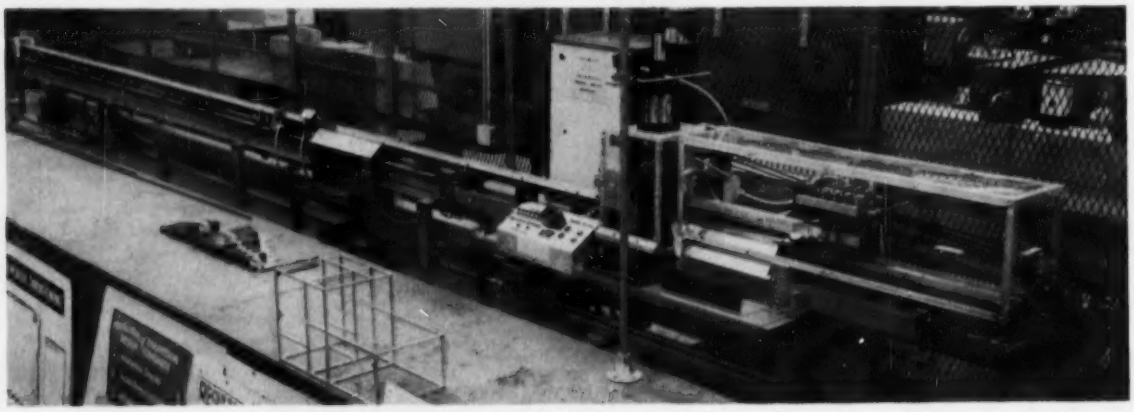
A SIMPLE BENCH-MOUNTED tool shears platinum contacts from rejected switch and relay springs in one easy operation in the Clifton, N. J. plant of Federal Telephone and Radio Co., a division of IT&T. The operator places the spring blade over a metal peg, brings the shearing arm up and back over the contact, then pushes the lever arm to shear off the precious platinum for salvage. Rejects are chiefly due to damage during welding of contacts.

Quick push on lever shears platinum contact off spring blade being held in position by finger of operator

Automatic Cutoff Machine Shears Square Tubing

THE VARIOUS LENGTHS of seamless square tubing needed for airborne electronic equipment housings are automatically sheared from raw stock by a cutoff machine developed in the Utica, N. Y. plant of GE's Light Military Electronic Equipment Department. The cuts are clean so no deburring is required, hence there is no loss of the initial 0.001-inch accuracy of dimensional control. Changeover to a new length takes no more time than is required to flip up to eight toggle switches to new settings.

▶ **Operation**—The operator loads a length of raw stock up to 20 feet long into the V-shaped input trough and pushes its end into a gripper spring so that the last remnant can be pulled out and ejected. Toggle switches labelled 0.1, 0.2, 0.4, 0.8, 1.6, 3.2, 6.4 and 12.8 are set to the total desired length in the machine's range of 1.4 inches to 15 inches, a counter is set to the number of pieces desired and the start button is pressed. This starts the feed motor, which drives a roller link chain through a gear box to move the stock in. The stock gripper spring is fastened to this



Complete automatic tubing cutoff machine. Tubing stock is loaded in at left end. In foreground is frame made from cut tubing

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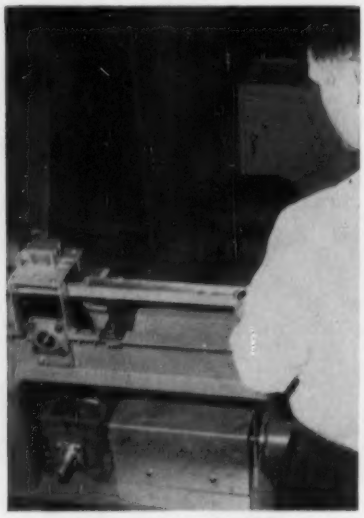
chain, which runs the length of the input trough.

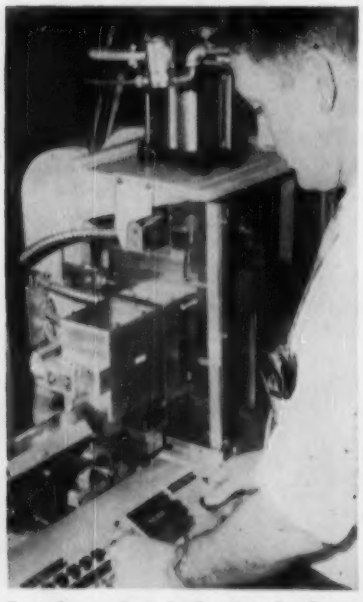
▶**Cutoff Action**—New stock is advanced about ¾ inch beyond the shearing blade and a trim cut is made automatically to give a square working surface. This scrap piece is pushed off into a scrap tray by a pusher arm so it does not get mixed with the precision cut lengths.

After the trim cut is made, a hydraulic positioner on the output side of the machine comes in to bring the stop mandrel to the switch-selected position. Commutator bars produced by printed wiring techniques act through servo controls to permit pre-sensing of the desired position through an incremental positioner to slow up the hydraulic arm, so it is almost stopped at the instant when the square latch of the mandrel comes into the correct notch on the positioning mechanism.

With the mandrel in position, the drive motor advances the tubing to the mandrel stop and a large hydraulic cylinder is actuated to shear the tubing to length. The cut length is ejected into an output tray and the stock is advanced to repeat the cutting cycle.



Input end of machine, showing operator pushing fresh length of tubing into gripper spring attached to feed chain running in V-shaped trough. Drive motor is below



Control panel and shearing head at center of machine. Operator is setting toggle switches to desired length with left hand. Thumb of right hand is on start button

▶**Shearing**—An unusual cutting tool design gives clean, distortionless shearing of square tubing without using a mandrel inside the tubing. About 1/10th inch of material is sheared out in two pieces by the tool, in the manner shown in Fig. 1. The tool enters at a diagonal, pierces through, then pushes the sides outward simultaneously against the hardened edges of the dies through which the tubing passes. These dies are spaced apart the thickness of the shearing tool. Once the initial pierce is made by the point of the tool, further pressure on the tubing is outward, so there is no deformation whatsoever.

A carbide tool is used at present, but requires rather frequent resharpening. Experimentation with ceramic cutting tools is under way. Various shapes of carbide tools are being tried to lengthen tool life without deforming the tubing during the initial piercing cut.

▶**Tape Control**—The design of the length-setting controls is such that the machine can be hooked up directly to a punched-tape reader, for automatic control of quantity and length when producing short runs of various lengths of tubing needed for a complex frame shape. Standard Flexowriter tape will be used.

▶**Retraction**—When near the end of a length of stock, a snap-action switch is triggered if there is not sufficient stock left to cut out another piece. The position of this switch is changed automatically when the length setting is changed, so there is minimum waste of the costly precision tubing. The

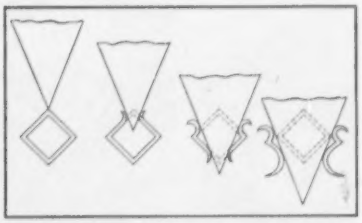
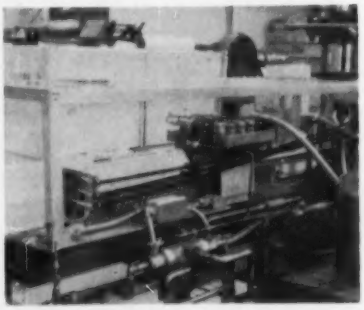
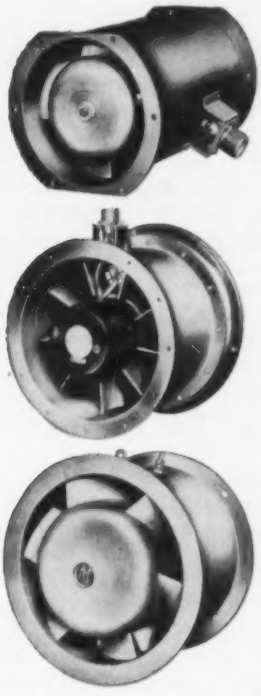


FIG. 1—Method of cutting tubing by shearing out a tenth-inch length in two sections. Shearing tool is 0.1 inch thick and just fits between ends of square shearing dies through which tubing passes with snug fit

Output end of machine, with finished lengths of tubing in open-end tote tray



Rear view of hydraulic positioner, showing slanted commutator bars that serve to slow up positioner as it approaches correct position



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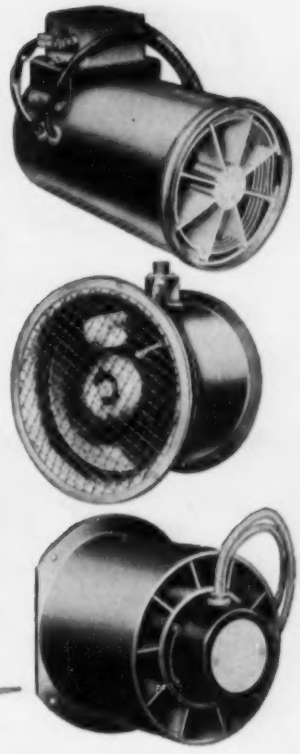

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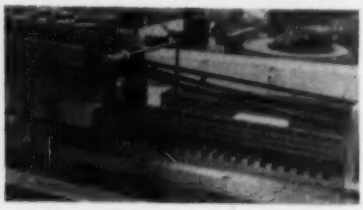

Hydraulic positioner at output end of machine, working in conjunction with notches on bed to place tubing stop at correct position for desired length

switch is triggered by the tubing gripper spring. This switch in turn makes the drive motor reverse and retract the feed mandrel, then signals the operator to put in new stock. If the predetermined count runs out before the tubing is exhausted, the machine stops and waits for new orders, without retracting the stock. The tubing is welded together or pushed over precision corner fittings.

Single-Worker Turntable For I-F Strips

TRAINING TIME is greatly reduced during production of complex Tacan equipment by using turntables that allow a single operator to install a part in up to ten units one after another. The sequence is then repeated for each additional part in turn. The technique is used by Federal Telephone and Radio Co., division of IT&T, for assembling i-f amplifier strips and other subassemblies for Tacan receivers and transmitters.

When an operator has completed assembly and soldering on a batch of ten subassemblies, she moves to another turntable and starts over again. In the meantime, an inspector goes over the assembled units and sees that repairs are made if necessary, before authorizing their removal. This minimizes handling of units and leaves them in the optimum position for repair work.

▶ **Turntable Construction** — The circular turntable is cut from 1¼-in. plywood and is mounted on a vertical pipe shaft at its center. On the supporting base are five upended ball-bearing casters on which the table can be freely rotated by hand. The top of the turntable is 23 in. above the floor, this being the most convenient height for a person sitting on a chair.

▶ **Turntable Fixtures**—The ten work-holding fixtures mounted on each turn-table are universal in design to take a variety of different terminal strip and chassis sizes. A single bolt holds the fixture bracket on the turntable, so the operator can easily rotate a fixture to the most convenient working angle.

Terminal boards are gripped at

Assembling I-f terminal boards on single-operator turntable. Bent upper part of turntable shaft supports solder spool. Molded plastic rotating tray on floor stand at right holds needed components. Job card book above tray has one instruction card for each component to be installed

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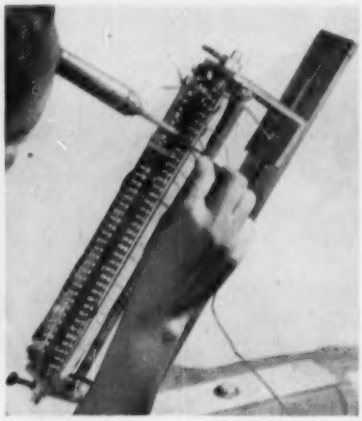


Coil springs alongside terminal board on holding fixture help support leads and keep them straight. Thumb nuts make fixture universal

their ends by metal clamps tightened with thumb screws. The bracket for the upper holding clamp can be slid up or down on a slot in the main angle bracket to accommodate different board lengths.

Board-holding grips are mounted on individual shafts that permit rotating the terminal board or turning it upside down. Thumb nuts on the brackets can be tightened to lock the board into position at the desired angle.

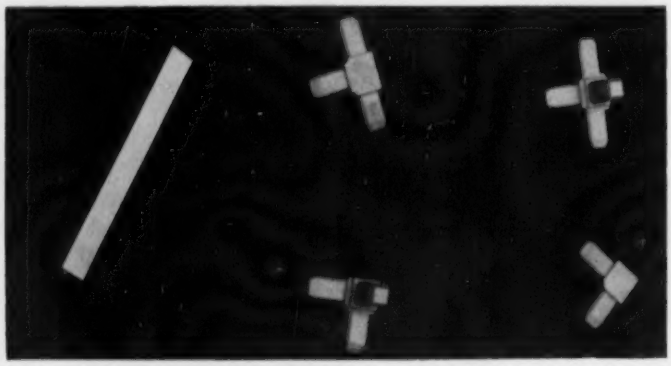
On each side of the board are springs that hook over bolts projecting out from the hold-down clamps. These springs hold leads in position during soldering and keep them straight during the assembly work.

▶**Job Cards**—Another factor contributing to greatly reduced training time is the job card book. This has an individual card for each component, identifying it and giving assembly instructions. The cards are held together by a ring binder. After installing the same part in each of the ten units the operator turns to the next card, studies it for a few moments, then proceeds to carry out its instructions on each of the ten units in sequence.

All components needed for a particular subassembly are brought to the operator in one convenient molded-plastic circular tote tray. This sets on a single-pipe floor stand and rotates freely. A short length of rod fitting into the top of this stand holds a shelf for the job card book.

Corner Castings Eliminate Tubing Welds

SIX STYLES of corner fittings for 0.3-inch-square chrome-molybdenum steel tubing have replaced welding in the assembly of frames for housings of airborne military electronic equipment in GE's Light Military Electronic Equipment Department in Utica, N. Y. With these fittings and with a supply of tubing cut precisely to various lengths, an operator can assemble a complex frame shape and attach side panels to it in approximately the same time required formerly for welding the tubing. The resulting frame is better, however,



Examples of corner brackets and square tubing used to assemble frames of equipment housings without welding

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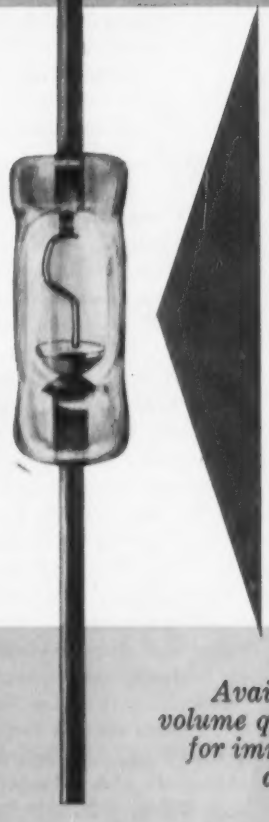

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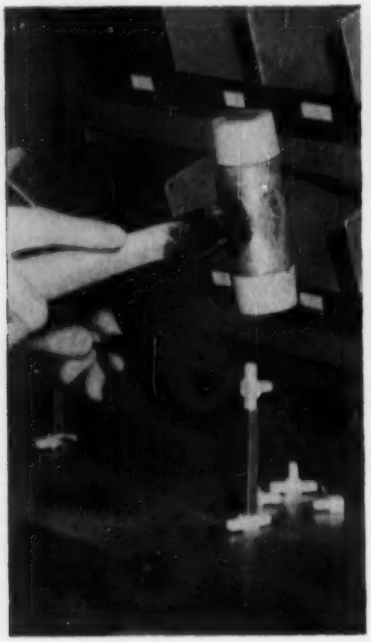
Holding tubing in position on adjustable stop of arbor press, in preparation for driving fitting into end of tubing

Method of inserting adjustable stop in holding fixture on arbor press, to provide level shelf for tubing

because no material is ground off during the finishing operations formerly required after welding. It is strong enough to meet all applicable military specifications yet costs considerably less than a comparable welded frame design.

▶ **Assembly of Fittings**—A standard hand-operated arbor press is used as much as possible for forcing the fittings into the ends of tubing prior to assembly. A metal fixture with adjustable stops is bolted to the bed of the press to



Crimping tubing over fitting with bench-mounted tool. Resulting joint provides required strength for shock and vibration tests

Fourth side of rectangular frame is assembled by tapping in fittings alternately with plastic-faced mallet

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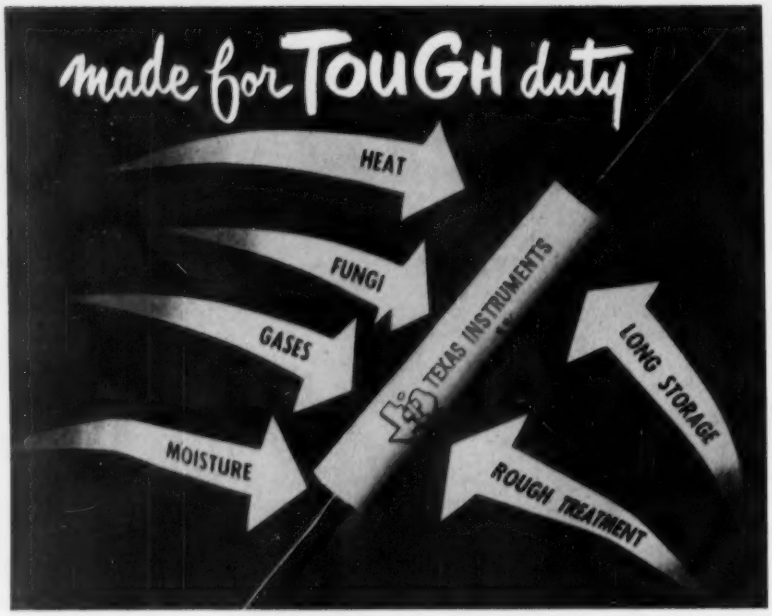

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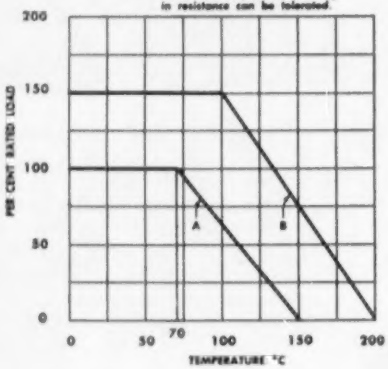

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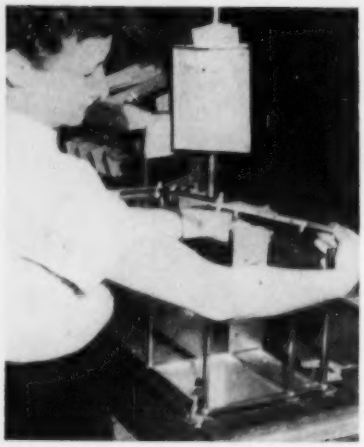
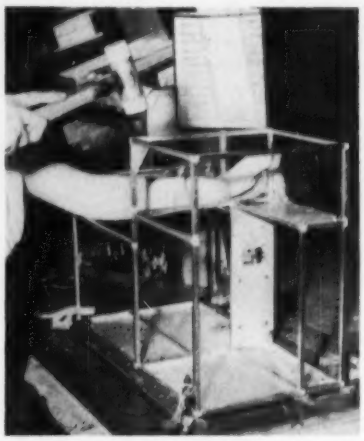


As work progresses, frame is transferred to bed plate having hold-down clamps. Plastic strips protect panel at bottom of frame here. Frame section held by operator will be tapped into position with mallet



Tapping final section of frame into position. Interior panels are riveted to frame sections before final assembly

accommodate different lengths of tubing. The operator holds the tubing over the stop with her left hand, places a fitting on the upper end of the tubing in correct orientation with her right hand, then operates the press with her right hand to drive the fitting into the end of the tubing.

When the assembly becomes too large or awkward for the press, the work is then transferred to a heavy steel plate on the bench. Here the fittings are tapped into position with a plastic-faced mallet.

As each rectangle or other section of the final assembly is completed, the ends of the tubing are locked into place over the fittings

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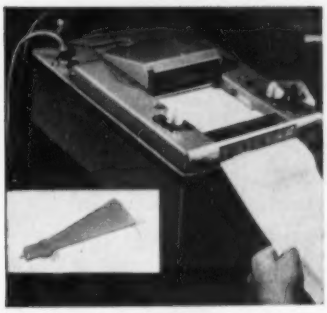
PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

No. 11, 1956

Heat resistance, low friction of TEFLON® solves design problem in miniaturization of potentiometers

Du Pont ZYTEL® provides needed insulation in strong, lightweight parts

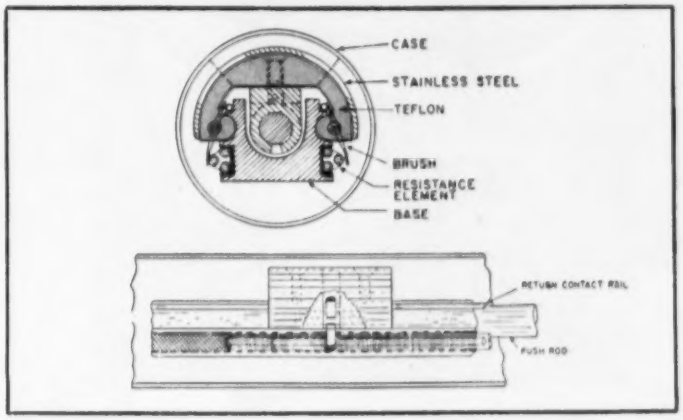


Marking electrodes, housed in Du Pont "Zytel" nylon resin, trace impulses on electrosensitive paper. "Zytel" is used because of its insulating properties and its strength in thin sections. (Recorder manufactured by Alden Electronic & Impulse Recording Equipment Co., Alden Research Center, Westboro, Mass.)

With the Alden 30-channel recorder, up to 30 machines can be monitored remotely and their records studied for optimum scheduling, and downtime. Tiny motion switches mounted on the machines and activated by machine motions transfer electrical currents to the recorder. The currents then activate electrodes that mark out lines on electrosensitive paper, providing a permanent record of operating cycle, and downtime.

One of the problems in developing the recorder was to find a material to house the marking electrodes. It had to be lightweight, strong, provide good insulating properties, and be economical to produce.

The manufacturer solved the problem with Du Pont "Zytel" nylon resin. This engineering material is strong, even when molded in thin sections. The metal inserts form an integral part of the marking electrodes because "Zytel" can be injection-molded around these inserts. With this method there are fewer parts, and assembly costs are reduced. The holders of "Zytel" can be produced in a variety of attractive colors.



Cross section of typical dual rectilinear potentiometer with insulation of "Teflon." Du Pont "Teflon" protects the core from heat and friction.

Miniaturization in guided missiles and other airborne equipment necessitates improvement in design and insulation of potentiometers. Du Pont "Teflon" tetrafluoroethylene resin fills the insulation requirements. A trunnion pin fitted into two shoes of "Teflon" holds the double-leaf brush in the new line of high-temperature potentiometers manufactured by the Pacific Scientific Company, Los Angeles, California.

The importance of "Teflon" in this application stems from its high heat resistance and low coefficient of friction. In use, this potentiometer must operate at temperatures as high as 400°F. and intermittently to 550°F. "Teflon" insulates the potentiometer and protects the core. The movement of the sleeve calls for a material with a low coefficient of friction. "Teflon" solves this problem, too.

"Teflon" offers a combination of electrical, chemical and mechanical properties that makes it well suited for use in high-frequency, high-temperature and some high-voltage applications; in applications such as this, where miniaturization and compactness of design are essential; and for uses where equipment is exposed to corrosive action.

NEED MORE INFORMATION?

CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.

**"Teflon" and "Zytel" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.).*

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department
Room 2211, Du Pont Building, Wilmington 98, Delaware

In Canada: Du Pont Company of Canada Limited,
P. O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: ☐ "Teflon"* tetrafluoroethylene resin and ☐ "Zytel"* nylon resin.

I am interested in evaluating these materials for_____

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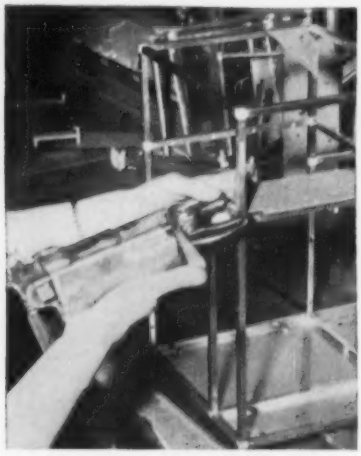
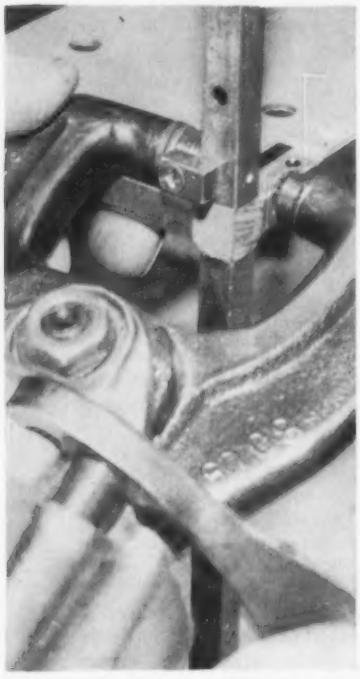
with an air-operated crimping tool mounted on the workbench. As the frame reaches final shape, a portable version of this tool completes the crimping. The crimper is a CP-214 compression riveting tool made by Chicago Pneumatic Tool Co., Utica, N. Y. The hand-held unit is operated by a finger



Crimping tubing of completed frame with hand-held tool

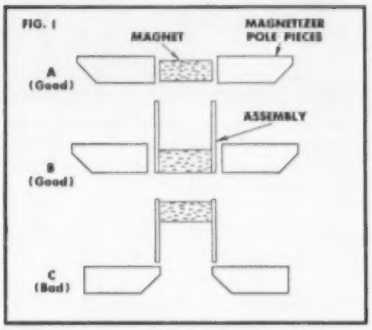


Appearance of joint after crimping. Pivoted block on left jaw of crimping tool is attached to washer for free rotation, to give precise positioning of dimple in center of tubing for any working angle of tool

INDIANA PERMANENT MAGNET DESIGN INFORMATION

published for industrial and consumer product engineers and designers

HOW TO MAGNETIZE PERMANENT MAGNETS



Magnetizing permanent magnets after assembly into the product offers several advantages. Higher field strengths are obtainable. The magnetic field produced in a loudspeaker, for example, using an Alnico V permanent magnet that has been magnetized after assembly, is about three times as great as the field obtained when the same magnet is magnetized before assembly.

The unmagnetized magnets are easier to handle and to assemble with other parts of the assembly. There is less contamination due to pick-up of magnetic particles.

Magnetizing after assembly is also advantageous in such applications as watt hour meters, polarized relays, and permanent magnet motors.

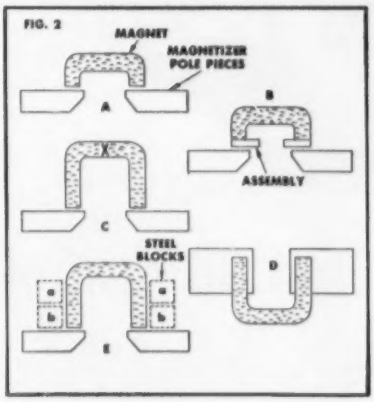
Using the Magnetizer

Most commonly used magnets are of simple bar or "U" shapes, which may be magnetized with an electromagnetic magnetizer in the user's plant.

Fig. 1-A shows how a bar magnet should be positioned between the magnetizer's pole pieces. The square ends of the pole pieces are used toward the gap. The space between the pole pieces is adjusted so the magnet can be easily inserted and removed. Normally, only one to two seconds are required to fully magnetize the magnet.

An assembly consisting of a bar-type magnet and soft-steel pole pieces should be placed with the magnet between the magnetizer pole pieces as shown in Fig. 1-B. Positioning the assembly as shown in Fig. 1-C will not fully saturate the magnet.

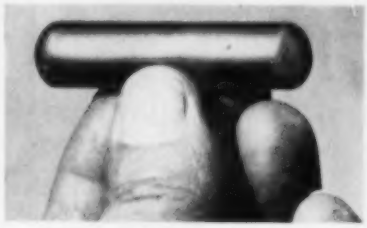
"U" shaped magnets and assemblies should be positioned as shown in Fig. 2, with the tapered ends of the magnetizer pole pieces used toward the gap. A meter or separator assembly would be placed on the magnetizer as shown in Fig. 2-B.



When a "U" shaped magnet is tall or larger than the generally accepted setting of the magnetizer, the field produced at point "X" (see Fig. 2-C) may not be sufficient to saturate the magnet. In this case there are two acceptable methods of magnetization. One is to place the magnet with its side on the pole pieces as shown in Fig. 2-D. This allows the yoke of the magnet to become magnetized. The magnet is then raised to the position in Fig. 2-C and again magnetized.

The other procedure is to stand the magnet on the magnetizer pole pieces with one or two steel blocks against each of its legs as shown in Fig. 2-E. The magnet (or assembly) is then magnetized three times: first, with both pairs of blocks in place; second, with blocks (a) removed; and third, with blocks (b) also removed.

For a complete discussion of how to magnetize permanent magnets by the electro-magnetic method, write for a copy of *Applied Magnetics*, Vol. 2, No. 3.



Magnets protect Bossie from Stomach-aches

Cows often gulp down, with their food, various and sundry items including a surprising volume of nails, staples, wire and other metal objects. As a result, Bossie frequently gets a stomach-ache called "hardware disease."

The sharp edges of the stray metal often pierce her stomach wall, and can easily cause death.

To prevent the costly disorder, you simply feed the old girl an Indiana "Cattle Magnet." The magnet remains in her first stomach, gathering the stray bits of metal as they appear. This keeps them from passing to her other stomachs (she has four, you know) where they can cause damage.

Report on Indox I Ceramic Permanent Magnets

This recently published four-page technical bulletin, "Indox I Ceramic Permanent Magnets," suggests factors to be considered during design calculations, and discusses possibilities for new applications or improvements of existing ones.

Also discussed are some 30 representative sizes and shapes available in sample quantities for immediate shipment. Ask for price list and Catalog 15-A-11.

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THERMAL TIME DELAY RELAY

For applications of time delay in electrical circuits the "Snapper" thermal time delay relay makes and breaks contact with positive action. The switching takes place with a minimum of arcing and thus potential chatter is eliminated, insuring long life.

The "Snapper" has single-pole double-throw contacts, operates throughout an ambient temperature range, is hermetically sealed and gas filled and is reliable and rugged. It is available in a metal envelope in either (7 or 9 pin) miniature or (8 pin) octal and also in a glass envelope in 9 pin only. The delay periods are preset in metal from 3 to 90 seconds and in glass from 5 to 60 seconds.

Curtiss-Wright also manufactures the "Snapper" High-Low Differential Thermostat. This unit meets industrial and military needs. Write to Thermal Devices Division for complete information.

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • CARLSTADT, N. J.

Holding woven aluminum bonding over tubing with masking tape, in preparation for riveting panel into position on frame for airborne jammer

trigger, and the bench unit by a foot pedal.

▶ **Assembly of Panels**—After assembly of the frame, it is placed in a jig set into the bench and the various panels are fastened into position one by one with a pneumatic riveter using Cherry rivets.

On panels requiring good r-f

Assembled frame is held by holding fixture built into work bench while riveting panel to frame, using Cherry rivets shown on wire in foreground

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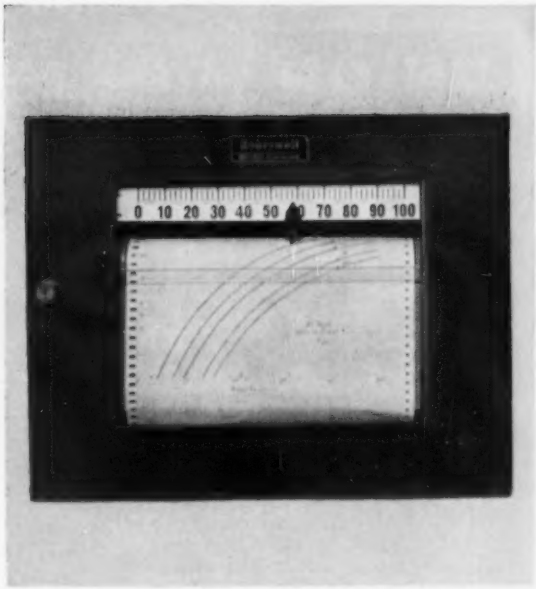
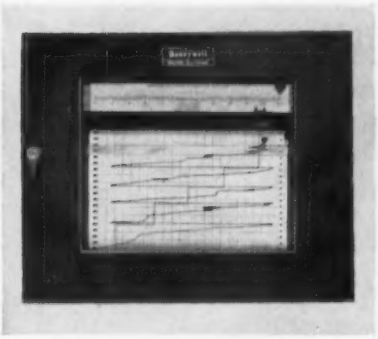
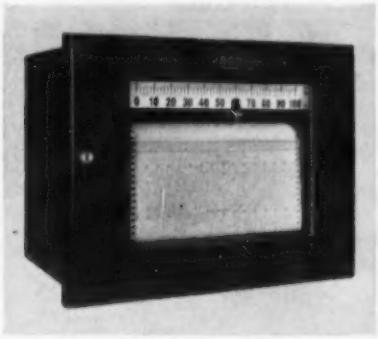


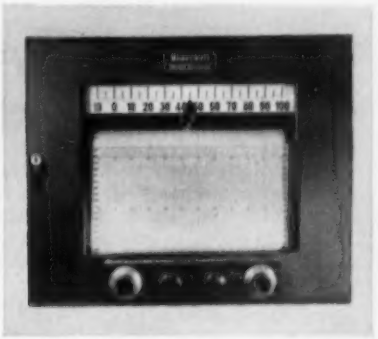
ElectroniK **FUNCTION PLOTTER** Automatically and continuously plots a curve which shows the relationship of one variable to another. Typical uses: speed versus torque, stress versus strain, temperature versus pressure, plate voltage versus plate current (and other electron tube characteristics), and many other variable relationships. *Write for Instrumentation Data Sheet 10.0-5b.*



ElectroniK **EXTENDED RANGE RECORDER** Facilitates measurement of any linear variable whose values change over a wide range, and where precise evaluation and good resolution are important. This instrument is particularly suited to the measurement of forces in conjunction with a strain gage bridge. *Write for Instrumentation Data Sheet 10.0-18.*



ElectroniK **NARROW SPAN RECORDERS** Accurately measure d-c potentials as low as 0.1 microvolt and spans as narrow as 100 microvolts. Available as a precision indicator, circular chart recorder, and strip chart recorder. Useful (with appropriate primary measuring elements) for measuring differential temperatures and slight variations in the temperatures of small objects through the use of radiation pyrometry. *Write for Instrumentation Data Sheet 10.0-8.*



ElectroniK **ADJUSTABLE SPAN RECORDER** Measures spans and magnitudes of a variety of emf's. Instrument calibration can be in terms of any variable reducible to d-c voltage. Can be used with thermocouples, steam gages, tachometers, and other transducers. *Write for Instrumentation Data Sheet 10.0-10a.*

Your nearby Honeywell sales engineer can give you complete information about these instruments as they relate to your particular applications. Call him today . . . he's as near as your phone. MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa. —in Canada, Toronto 17, Ontario.

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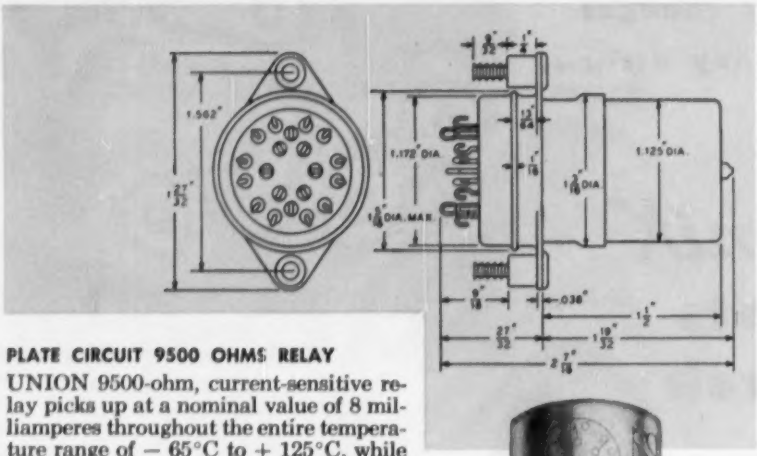


PLATE CIRCUIT 9500 OHMS RELAY

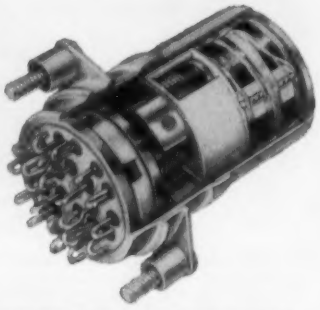
UNION 9500-ohm, current-sensitive relay picks up at a nominal value of 8 milliamperes throughout the entire temperature range of − 65°C to + 125°C, while maintaining the excellent shock and vibration characteristics inherent in our standard design. It can withstand 200 volts across the coil continuously.

These current-sensitive relays have a life expectancy of 100,000 operations. They meet or exceed all requirements of MIL-R-5757-B and withstand shock up to 50G's, vibration through 1500 cycles at 15G's.

AC SELF-CONTAINED RECTIFIER RELAY

UNION AC relay with self-contained rectifier retains all the best operating characteristics of the type M DC miniature relay. It permits operation in 115-volt, 60 to 400-cycle circuits over a temperature range of − 55°C to 85°C. Withstands vibration up to 1000 cycles at 15G's and shock in excess of 50G's. Has a life expectancy of 1,000,000 operations. Meets or exceeds MIL-R-5757-B.

All the above relays are available in 6PDT or 4PDT models, with all the usual mountings and with plug-in or solder-lug connections.



DRY CIRCUITRY APPLICATIONS

In grid-switching applications where the relay contacts must operate at low-voltage, low-current levels, special gold-alloy contacts have proven highly reliable. They maintain their low resistance through hundreds of thousands of operations. They are available on the complete line of UNION miniature relays.

Complete stocks of relays and selenium rectifiers now available on the West Coast for immediate shipment.

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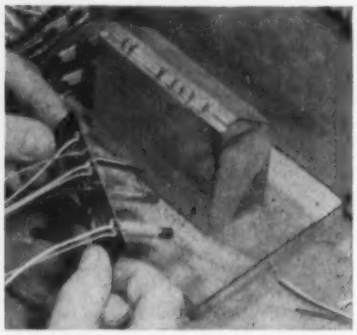
bonding and shielding, woven aluminum bonding strip is placed over the tubing and held in position with masking tape over the ends that are run down the sides. After the panel is riveted the tape is removed and the tab ends of the woven bonding are cut off.

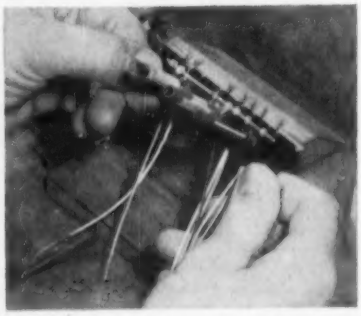
► **Costs**—After an initial tooling investment of $6,540 for investment casting molds, the corner fittings can now be manufactured at a cost of approximately 20 cents each. This cost is highly favorable in comparison with the cost of the fifty special welding fixtures formerly required, plus the repetitive costs of grinding off welding flash and plating the entire frame after assembly.

Lead-Bender

A SIMPLE WOOD BLOCK mounted on a bench serves efficiently for bending seven insulated leads at right angles under a Bakelite strip that supports the three coils of an auto-radio tuner. Holding the insulating



Appearance of coil strip before leads are bent. Shelf cut in front edge of block supports side of insulating strip. The seven notches provide clearance for terminals



Bending leads with aid of wood block

UNIVERSITY OF CALIFORNIA RADIATION LABORATORY · *Berkeley* *Livermore*

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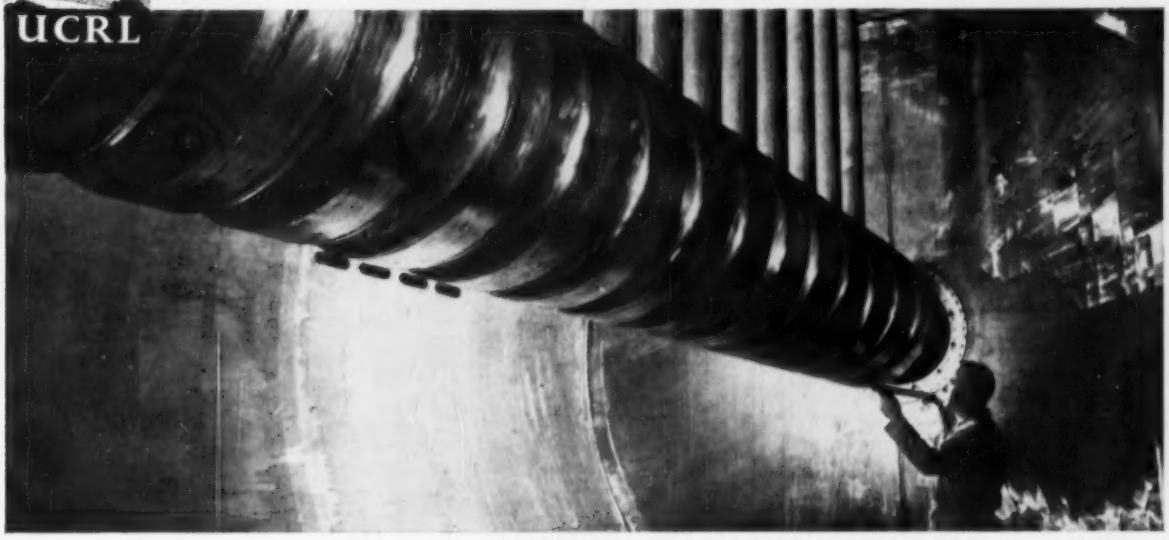

At UCRL's Livermore, California, site—interior view of drift tubes in high-current linear accelerator designed to deliver 250 ma of 3.6 Mev protons or 7.8 Mev deuterons

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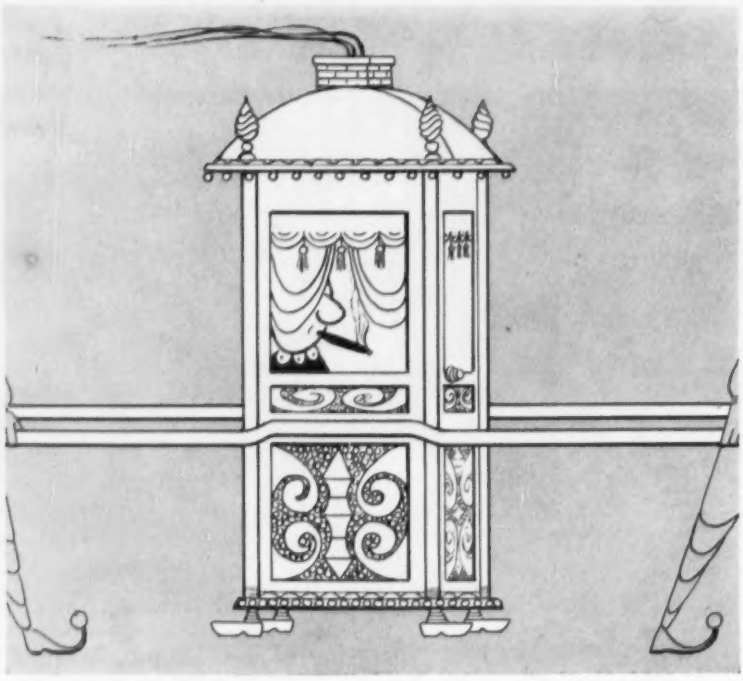

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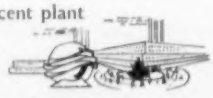

His lot is not that of his father's, when hard work was looked upon as a virtue and something to be proud of. The Engineer at Sigma devotes his day to stimulation, and receiving the plaudits of his fellows. Similarly, at his luxurious home in the sylvan setting known as South Braintree, the Sigma Engineer's wife fairly bursts with happiness,

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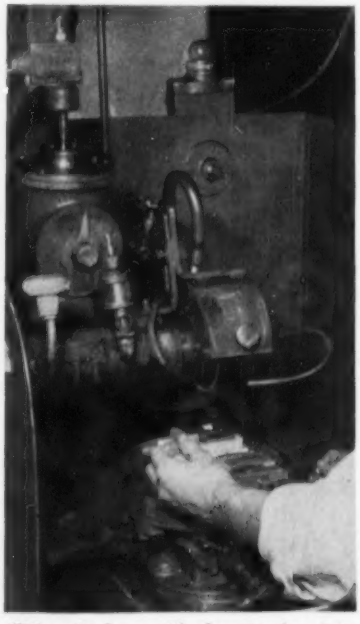
strip by its ends, with the coils upright and the leads extending straight down, the operator brings the leads up to the seven grooves cut into the wood block and rests the side of the strip in a shelf of the block. She then rotates the strip downward while pressing against the block to bend all seven leads simultaneously until they are flat against the bottom of the strip.

This technique is used in the Camden, N. J. plant of Radio Condenser Co.

Automatic Dicer for Germanium Slabs

A DIAMOND SCRIBE mounted on the end of an automatically indexed rack-and-gear arrangement slices germanium slabs into strips and then dices up the strips into pellets for use in surface-barrier transistors manufactured by Philco in its Lansdale, Pa. plant. The operator merely needs to load in the raw material and, in spare time, separate out the unusable corner pieces.

► **Slicing** — In the machine setup used for slicing a circular cross-



Slicing single crystal of germanium into slabs with diamond saw. Ingot is cemented to ceramic block held in work-holding fixture. Diamond saw is smoothly lowered through ingot and ceramic block by hydraulic feed mechanism

. . . and cuts the size and weight of cable

Federal's miniature coaxial cables—about ¼ the size of comparable RG types—save critical space and weight in aircraft and instrument uses.

Challenged by the high temperature and minimum weight requirements of jet aircraft and guided missiles, Federal has designed RG cables that perform perfectly at a blistering 500° F.! New Federal miniature coaxials have a top temperature rating of 150° C. . . . up to 200° C. with an impregnated fiber glass jacket!

The key to these new cable developments lies in advanced designs.

Based on utilization of "Teflon," this superior dielectric maintains its excellent low loss and high voltage characteristics through a temperature range of 500° F. to −100° F. "Teflon" has no measurable water absorption; it is chemically inert . . . unaffected by alkalies, acids, aromatic fuels, aromatic organic solvents, and highly corrosive aviation hydraulic fluids.

If your cable problems involve heat, space or weight, it will pay you to consider Federal's new "Teflon" insulated cables. For information, write Dept. D-913C.

"TEFLON" HIGH TEMPERATURE CABLES

RG-87A/U 50 ohms; 69.5% V.P.; 29.5 mmfd/ft. Cap; 4,000 operating volts.

RG-140/U 75 ohms; 69.5% V.P.; 29.5 mmfd/ft. Cap; 1,700 operating volts.

RG-141/U 50 ohms; 69.5% V.P.; 29.0 mmfd/ft. Cap; 1,500 operating volts.

"TEFLON" MINIATURE COAXIAL CABLES

K-256 50 ohms; 29 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 13 db/100 ft. Atten. at 400 mc; 0.095 O.D. dielectric; 7/30 silver-plated Copperweld conductor; 0.135 O.D. jacket.

K-257 70 ohms; 21 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 14 db/100 ft. Atten. at 400 mc; 0.095 O.D. dielectric; 7/34 silver-plated Copperweld conductor; 0.135 O.D. jacket.

K-258 93 ohms; 16 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 15 db/100 ft. Atten. at 400 mc; 7/38 silver-plated Copperweld conductor; 0.135 O.D. jacket.

"TEFLON" HOOK-UP WIRE—Type E, EE and FF Hook-Up Wires meet MIL-W-16878A. Available in all standard colors.

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In Canada: Standard Telephones and Cables Mfg. Co. (Canada) Ltd., Montreal, P. Q.
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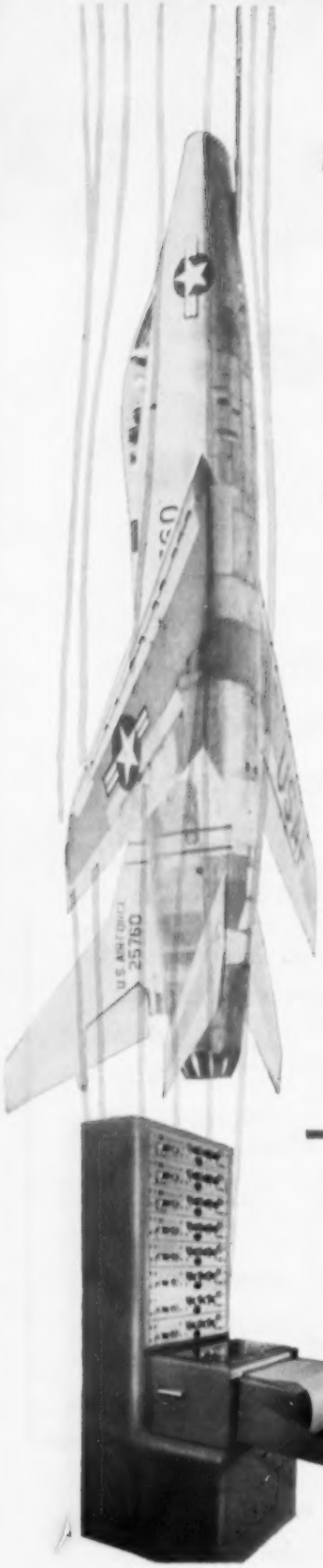


What holds this heavyweight battler up...?

Obviously, the North American F-100 Super Sabre flies because it fulfills the aerodynamic laws relating to lift and weight, thrust and drag.

But before an F-100 leaves the ground, its probable conformity to these laws is measured with great care and compared to the data acquired during 50-plus years of aeronautical experience to insure peak performance under the stresses of high altitude, supersonic combat.

Edin Electronic Instrumentation is a key element in flight simulation and pre-flight testing during design and production stages at North American Aviation. In the case of the F-100, custom-adapted 8-channel Edin Recording Oscillographs serve as direct-writing indicators to record aircraft responses as simulated by analog computers.

● NEW OSCILLOGRAPH FLEXIBILITY

You, too, can benefit from the amazing flexibility Edin Oscillograph Recorders can provide. For Edin now offers a completely redesigned recording instrument in two models: with modular interchangeable preamps and basic amplifiers; and with standard rack-and-panel single-chassis amplifiers. Modular unit takes up to 8 preamps in the control panel, with amplifier chassis mounted in the lower section of the housing. Records up to 8 channels of transient data simultaneously. User may begin with two channels and add preamps and galvanometers as required.

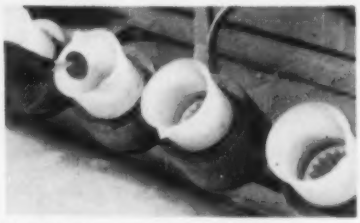
A wide choice of amplifiers is available including:

Type	Model	Gain*	Response	Noise Level RMS**
High Gain DC	8238	5,000	DC-5K	10uv
Low Gain DC	8231	125	DC-5K	50uv
Condenser Coupled	8234	10,000	1-3K	10uv
High Gain CC	8235	500,000	1-3K	5uv
Modulator	8236	20,000	DC-60	20uv
Pressure	8241	20,000	DC-60	20uv
Stabilized DC	8239	10,000	DC-3K	20uv
Carrier	8237	500,000	DC-500	5uv

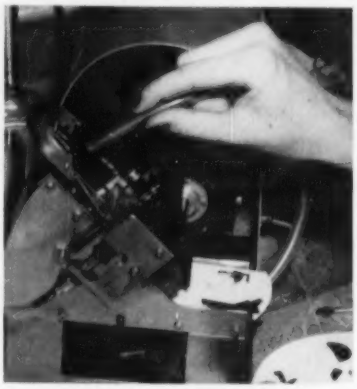
**Preamp and amplifier*
***In microvolts referred to input*

Write for informative, illustrated literature on oscillograph recording instruments and accessories.

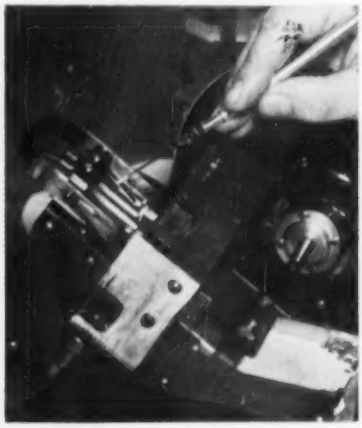
EDIN COMPANY, INC.
207 Main St., Worcester, Mass., U.S.A.



Mounting arrangement of Teflon beakers in rotating holders, used for etching germanium slabs down to desired thickness for transistor blanks or dice



Germanium slab stored in alcohol-filled glass dish is picked up with vacuum hose and transferred to holding fixture of slicing machine as shown here.



Using vacuum chuck to load germanium strip into feed groove of automatic dicing machine. Vacuum is released by removing forefinger from hole in side of chuck

section slab of a single crystal, the slab is loaded into position on its holding fixture with a vacuum hose having a thumb hole for controlling the vacuum. The slab is held in position by a yoke-shaped lever mechanism held down by appropriate springs.

The motor-driven scoring bar operates continually with about 15

DOW CORNING CORPORATION

Silicone Dielectrics

ELECTRICAL AND ELECTRONIC NEWS No. 8

SILICONE DIELECTRIC COMPOUND LUBRICATES, STOPS CORROSION

A silicone dielectric compound, Dow Corning 5 is growing in popularity for a wide variety of industrial and public utility applications. That's because the compound possesses excellent water repellency and corrosion resistance in addition to its superior dielectric properties.

A leading public utility company reports a thin film of Dow Corning 5 on insulators reduces electrical leakage to a new minimum by preventing the formation of continuous, conducting moisture films.

Furthermore, the film maintains high surface resistivity despite heavy contamination by air-borne fly ash, cement dust and earth particles. Its effectiveness appears to persist without maintenance for many years.

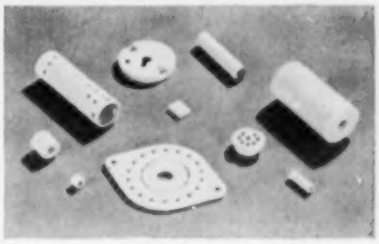
Non-melting and grease-like, Dow Corning 5 is also an effective, long lasting lubricant for switches, meters, condensers, recorders and similar mechanisms. It maintains lubricity at temperatures ranging from —100 to over 300 F and resists moisture, oxidation, salt spray and chemical attack.

A convincing demonstration of the versatility of Dow Corning 5 is provided by Col. K. C. Brown (USAR Ret.) who reports that the silicone compound has stopped salt water corrosion of the tackle blocks, brass and copper fittings, electrical connectors and battery terminals on his ocean-going ship "Sou'Wester". In the Colonel's words, "The results far exceed expectations. Fittings and connections show no sign of corrosion; terminals are electrically efficient." *No. 31*

Silicone Coating Cuts Cost of Ceramic Electrical Insulators

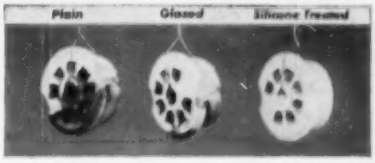
Imaginative use of new materials frequently enables designers to create a competitive sales advantage while cutting production costs. Here's a case in point from Centralab Division of Globe-Union Co., Milwaukee.

Centralab reports that a silicone treatment is rapidly replacing conventional glaze coatings on ceramic electrical insulators. Production savings with the silicone treatment range as high as several dollars per thousand units, permitting Centralab to quote competitively for ceramic against ordinary plastic molding materials.



The new treatment consists simply of a dip in Dow Corning 200 Fluid followed by a short baking cycle, contrasted to the costly individual air-brushing and high temperature kiln-firing required for a glazed surface. The silicone treatment gives equivalent or better moisture resistance and surface resistivity for all but the highest frequency applications.

Centralab now offers the silicone treatment on its entire line of steatite-ceramic parts including insulators, capacitor bodies, rotary switches and trimmers. Silicones have become such a strong selling point that, as a Centralab spokesman puts it, "Our sales department reviews every order or quotation request calling for glaze and recommends the silicone treatment where ever possible." *No. 34*



Greater moisture repellency of silicone treated ceramic tube socket is demonstrated by dunk test using colored water.

New Silicone Bonded Mica Tape More Flexible, Easier to Handle

Mica Coated Products Co., Salem, Mass., has developed an improved Class H insulating material comprised of a thin coating of ground mica bonded to glass cloth with Dow Corning 994 Varnish.

According to the manufacturer, this new combination provides greater dielectric strength and heat resistance than possible with silicone-glass alone. In addition, it has far greater flexibility than conventional tapes made with mica-splittings. A 5-mil thickness of it may be wrapped around a 1/32" mandrel without harm.

This new material is unusually uniform in gage, finish and dielectric strength. Since it is neither tacky or slippery, there is no danger of its welding together or blocking when guillotine-cut.

The flexibility of Dow Corning 994 Varnish and its compatibility with mica led to its use as the binder for ground mica coating on two other new tapes by Mica Coated Products Co.: an alkyd resin dipped glass cloth for temperatures up to 170 C; and Mylar, for Class B applications. The silicone-mica combination gives both tapes appreciably greater resistance to fire and arcing. *No. 32*

Silicone-Glass Laminates for electrical and mechanical applications are described in new brochure which illustrates parts used in typical industrial applications. Also provides engineering information on silicone-glass laminates and lists fabricators of such laminates. *No. 33*

Send Coupon for More Information

DOW CORNING CORPORATION · Dept. 4811
Midland, Michigan

Please send me 31 32 33 34

NAME _____

TITLE _____

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Canada: Dow Corning Silicones Ltd., Toronto; **Great Britain:** Midland Silicones Ltd., London; **France:** St. Gobain, Paris

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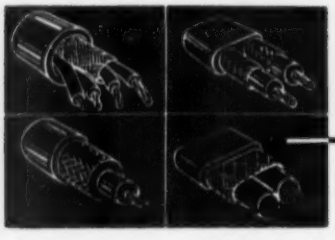
"Almost" is never enough when it comes to cable performances. You must be 100% certain the cable you select is custom-made to do the job your power engineering plans call for. You must know you can depend on cable performance in every respect.

Many of America's major users of cables have found they can depend on Phalo to produce *exactly* the cable needed.

Send Phalo a copy of your cable "specs". You'll discover a new kind of cable dependability.

Ask For The Complete Phalo Catalog



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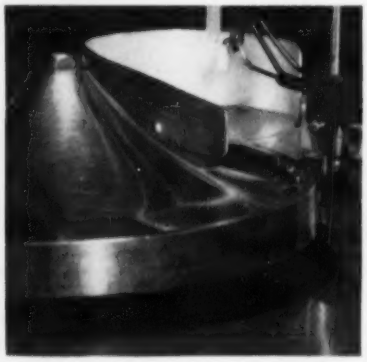
PLASTICS CORPORATION
The Custom Cable House
CORNER OF COMMERCIAL STREET
WORCESTER, MASS.
Insulated Wires, Cables – Cord Set Assemblies

markings per minute. This moves the diamond scriber forward across the bottom of the disk. At the end of this stroke, a spring steel blade operated by cam action breaks off the strip. Simultaneously, the motor-driven rod presses against a rubber bulb at the end of its stroke. The air from the rubber bulb is forced through small holes underneath the germanium slab so as to lift it up momentarily from its inclined base plate. The force of gravity then causes the slab to drop down against an appropriate stop to the next cutting position.

► **Dicing** — Cut strips are transferred to another machine that differs only in the work-holding fixture. Transferring is done with a vacuum chuck that is controlled by finger pressure over an air leak hole. Three strips are cut at a time. After each cut, pressure on

Transferring germanium pellets from watch glass to input cone of work feeder



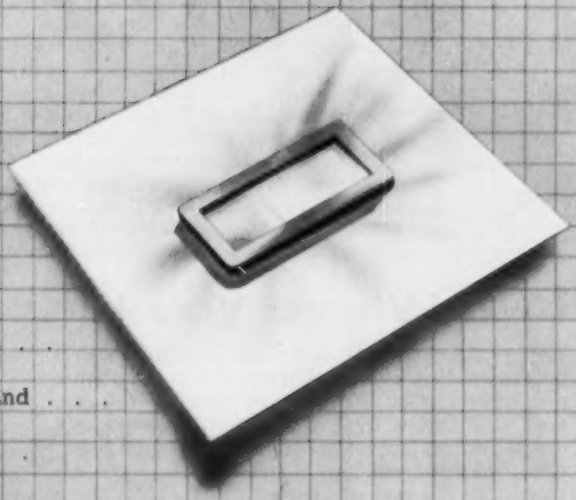
Closeup of input cone, showing nylon-tipped vacuum lifter used for picking up one blank or dice at a time automatically

Want more information? Use post card on last page.

FROM: Bomac

SUBJECT: The new BL 719 pressurizing window . . .

NOW - for the entire X band



Full X-band coverage: 8200-12,400 MC . . .

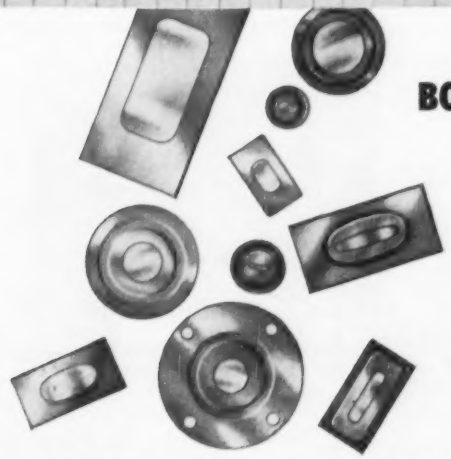
VSWR: not over 1.08 over the entire band . . .

Temperature range: -75° C to 100° C . . .

Truly nonresonant to handle higher powers . . .

Pressure differential: 17 lbs./sq. in. . . .

Solders directly to waveguide flange . . .



BOMAC produces a complete line of windows

Bomac manufactures a complete line of mica, glass, or ceramic pressurizing windows for all waveguide sizes — and offers experience and facilities unmatched in the industry for developing special windows to meet individual requirements. Bomac pressurizing windows are pressure and vacuum-tight — shock and vibration-proof — built to withstand pressures of 45 Psi, or more, and temperature ranges of −55° C to 100° C.

Write today for complete specifications.

Bomac Laboratories, Inc.

BEVERLY, MASSACHUSETTS

Offices in major cities:—Chicago • Kansas City • Los Angeles • Dallas • Dayton • Washington • Seattle • San Francisco • Toronto Export:—Maurice I. Parisier, 1860 Broadway, N.Y.C.

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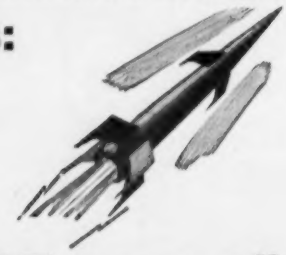
Physicists:



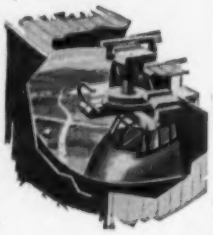
Work where PERFORMANCE pays off

Men of talent and drive can move ahead without delay or red tape at Melpar because skill, ability and performance are the *primary* factors governing advancement. Due to the fact that we've doubled in size every 18 months since our beginnings in 1945, middle and top level positions open up constantly.

Melpar believes that the engineer deserves an organization and facilities that can enhance his creative abilities. For this reason our laboratories were designed and built to specifications prepared by Melpar engineers. A wealth of equipment is available. Our project group system enables the engineer to participate in all phases of development problems and thus quickly acquire greater technical and administrative know-how, essential to eventual managerial responsibility. The system also enables us to more accurately evaluate the individual's contribution and more rapidly justify promotions.

Live Where You LIKE It

Living—for the whole family—is immensely rich in the two locales where Melpar's R & D activities are centered. Our 265,000 sq. ft. main laboratory near Washington, D. C., enables you to live in an area enjoying incomparable cultural and recreational advantages. The climate allows outdoor recreation 215 days of the year. Fine homes and apartments are available in all price ranges. Our Watertown and Boston, Mass. laboratories offer the unique advantages of cosmopolitan Boston with its theatres, concerts, art galleries, museums, universities and schools which are second to none. Nearby are seaside and mountain resorts offering a variety of winter and summer sports.



Openings Exist in These Fields:

Flight Simulators • Radar and Countermeasures • Network Theory • Systems Evaluation • Microwave Techniques • Analog & Digital Computers • Magnetic Tape Handling • UHF, VHF, or SHF Receivers • Packaging Electronic Equipment • Pulse Circuitry • Microwave Filters • Servomechanisms • Subminiaturization • Electro-Mechanical Design • Small Mechanisms • Quality Control & Test Engineering

Write for complete information. Qualified candidates will be invited to visit Melpar at Company expense.

Write: Technical Personnel Representative

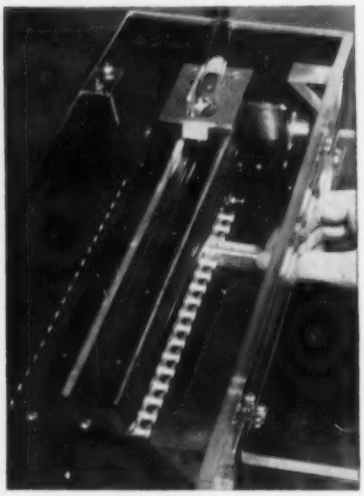
MELPAR, *Inc.*

A Subsidiary of Westinghouse Air Brake Company

3196 Arlington Blvd., Falls Church, Va.

10 miles from Washington D. C.

Openings also available at our laboratories in Watertown and Boston, Mass.



Thickness gage operates on principle of orange grader, wherein pellets drop between two rollers set at slight angle to each other. Machine can grade up to 3,600 pieces per hour into 18 metal boats below rollers, with typical variations of plus or minus 0.0001 inch

the air bulb produces an air blast that raises the remaining germanium piece so as to permit it to drop into its next cutting position. The dice which has broken off drops into an appropriate container.

▶**Sorting**—After dicing, the germanium pellets are transferred to the Syntron work feeder of an automatic sorter, for classifying into 18 different thickness groups differing in steps of 0.1 mil. The conical input of the feeder arranges the pellets end to end around the outer circumference. A vacuum lifter comes down automatically under cam action to pick up one pellet at a time and drop it down a funnel into a glass tube leading to the roller-type sorting gage.

The pellet drops between two long chromium-plated steel rollers

Transferring germanium pellets from alcohol rinse in beaker to vibrating screen under heat lamp

MEMO

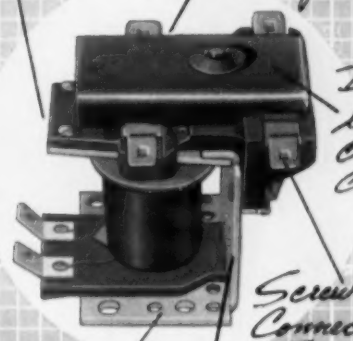
TO Engineering Dept.

SUBJECT **POWER APPLIANCE RELAY (TYPE 75)**

(IDEAL FOR PRINTED CIRCUITS)

This should fit in with Our cost reduction program.

Wm S


Molded Terminal Block, Actuator and Cover
"Hammer-Blow" Action on Contacts when Coil is De-Energized
Dust or lint contact cover
Screw or Quick Connect Contact Terminals
Rugged Magnet Frame
Variety of Mountings

Construction: Some of the outstanding design features of this Power Appliance Relay are a molded terminal block and actuator, a dust and lint hood over contacts, and a unique "hammer-action" on contact opening which actually forces contact open.

The R-B-M Power Appliance Relay is available either single pole normally open, or two pole normally open and will be furnished with screw or quick connect contact terminals.

A low wattage coil can be incorporated into the relay if ambient temperatures are higher than normal. All coil terminals are of the quick connect type.

Application: The Power Type 75 Appliance Relay has been designed for appliance applications where trouble-free operation and low cost are vital factors. Also, special ratings are available for inductive or motor loads. Pilot duty device normally connects coil to voltage source and contacts close the power circuit.

Screw Terminals

Exploded View Screw Terminals

Exploded View Quick Connect Terminals

ENGINEERING DATA	
Specifications	Power Appliance Relay Type 75
Contact Form	S.P.N.O. or 2 P.N.O.
Contact Ratings	25 amps. per pole resistive at 230 volts 60 cycle Inductive ratings—Consult factory for special inductive ratings giving details of application
Contact Terminals	Screw type or Quick connect type
Coil Terminals	Quick connect type
Coil Ratings	Up to 240 volts, 50 or 60 cycle (Standard Pick up 85% Rated) Volt Ampere Ratings (Approximate) **Armature Open** — 50 cycle 19, 60 cycle 16 **Armature Closed** — 50 cycle 13, 60 cycle 12
Design Ambient	120° F. Maximum*
Approx. Dimensions	2-31/64" x 2-35/64" x 2-1/4"

*Consult Factory Giving Specific Application Details for Higher Ambient.

CORD SETS
WIRE HARNESSES
MAGNET WIRE
OTHER PRODUCTS

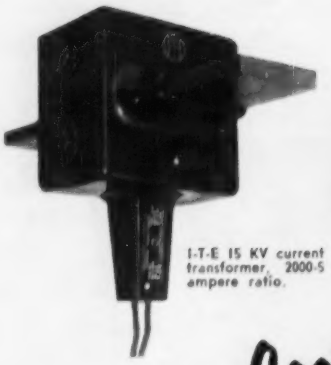
Send for Descriptive Bulletin

RBM DIVISION

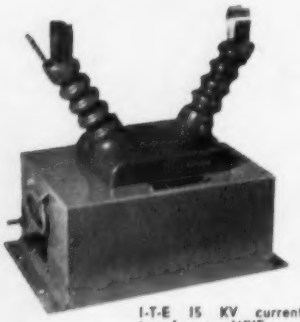
ESSEX WIRE CORPORATION, *Logansport, Indiana*

Want more information? Use post card on last page.

Circuit Breaker Company
Instrument Transformers



I-T-E 15 KV current transformer, 2000-5 ampere ratio.



I-T-E 15 KV current transformer, WYE connected 14,400-110 V. ratio.

Cast in
HYSOL 6800
Epoxy Casting Resin

HYSOL 6800 has proved to be the best and most economical epoxy casting resin for I-T-E Instrument Transformers, in an exclusive process developed by I-T-E.

When compared to other epoxies, HYSOL 6800, a highly filled hot melt, offers these outstanding features:

- Meets the requirements of Specification MIL-I-16923B, Types B and C
- Improved thermal shock resistance (–40°C to 130°C)
- High dielectric strength
- Low coefficient of linear thermal expansion
- Superior mechanical shock stability
- Self-extinguishing properties
- Good chemical resistance
- New economies

Using HYSOL 6800, transformer design engineers have found they can achieve reduction in size and streamlined appearance heretofore impossible.

Houghton Laboratories manufactures complete lines of Electrical Insulating Materials, Adhesives and Sealants, Tooling Materials and cast products as rod, sheet and tube.

PROGRESSIVE PRODUCTS
HYSOL
Product of HOUGHTON LABORATORIES, INC.
THIRD CHEMICAL RESEARCH

HOUGHTON LABORATORIES INC.
OLEAN, NEW YORK
In Canada
HYSOL (Canada) LTD., TORONTO, 17

that are mounted on an incline running down from the input end. The rollers are set at a taper so that they are closest together at the input end. They are chain-driven by an electric motor in such a direction that both rollers tend to push the pellet upward. Under the rollers are eighteen numbered boats for catching the pellets as they drop through. A pellet travels down between the rollers until it reaches the roller spacing corresponding to its thickness, then drops through into the boat assigned to that thickness. Oversize pellets drop off the lower ends of the rollers into a reject tray.

Tuning Capacitor Alignment Setup

GANG TUNING capacitors for military electronic equipment are individually aligned to an accuracy of hundredths of a micromicrofarad, to cover a total of 1,725 channels in 180 degrees of rotation, by bending serrated rotor-plate sections while the unit is mounted in a special calibrating fixture at Radio Condenser Co., Camden, N. J.

Toothed contact clips make firm connection with each stator section when the operator places a gang tuning unit in position on the fixture against guide blocks and moves a locking cam.

Next, using an accurately machined brass plate, she pushes the rotor plates down into the stator

Operator holds brass plate with left hand to obtain precise meshing of plates, while adjusting vernier of large calibrated dial so pointer reads 0. Hooded pilot lamp mounted on pointer improves accuracy of reading

SIZE
1-1/16 OD
1/2 H
32 MTG.

TYPES	Q max.	Freq.
MP206	140	14 KC
MP848	185	35 KC
MP608	170	60 KC
MP073	265	250 KC

SIZE
1-5/16 OD
23/32 H
6-32 MTG.

TYPES	Q max.	Freq.
MP930	160	8 KC
MP395	225	25 KC

SIZE
2 OD
1 H
8-32 MTG.

TYPE	Q max.	Freq.
MP254	210	6 KC

C-A-C®

TOROIDS – PLASTIC MOLDED

Now Less Cost Than Bare Unprotected Equivalents

MP (Molded Plastic) units are the result of a long development program. CAC MP toroids have repeatedly passed all tests for MIL-T-27, Grade 1, Class A without exception. Most compact design—may be stacked—mounted by center bushing—absorbs mounting pressures—sturdy plated terminals—standard inductance values listed below shipped from stock—complete Q versus frequency data at your request.

C-100

MOLDED AND CASED TOROIDS CARRIED IN STOCK *(Order by Part Number)*

Types also available in subminiature sizes . . . catalog on request.

MP206		MP848		MP930		MP395		MP254	
IND.	PART. No.	IND.	PART. No.	IND.	PART. No.	IND.	PART. No.	IND.	PART No.
5.0 MH	MP-206-1 –	2.0 MH	MP-848-1 –	5.0 MH	MP-930-1 –	5.0 MH	MP-395-1 –	20 MH	MP-254-1 –
6.0 MH	MP-206-2 –	2.4 MH	MP-848-2 –	6.0 MH	MP-930-2 –	6.0 MH	MP-395-2 –	24 MH	MP-254-2 –
7.2 MH	MP-206-3 –	3.0 MH	MP-848-3 –	7.2 MH	MP-930-3 –	7.2 MH	MP-395-3 –	30 MH	MP-254-3 –
8.6 MH	MP-206-4 –	3.6 MH	MP-848-4 –	8.6 MH	MP-930-4 –	8.6 MH	MP-395-4 –	36 MH	MP-254-4 –
10 MH	MP-206-5 –	4.3 MH	MP-848-5 –	10 MH	MP-930-5 –	10 MH	MP-395-5 –	43 MH	MP-254-5 –
12 MH	MP-206-6 –	5.0 MH	MP-848-6 –	12 MH	MP-930-6 –	12 MH	MP-395-6 –	50 MH	MP-254-6 –
15 MH	MP-206-7 –	6.0 MH	MP-848-7 –	15 MH	MP-930-7 –	15 MH	MP-395-7 –	60 MH	MP-254-7 –
17.5 MH	MP-206-8 –	7.2 MH	MP-848-8 –	17.5 MH	MP-930-8 –	17.5 MH	MP-395-8 –	72 MH	MP-254-8 –
20 MH	MP-206-9 –	8.6 MH	MP-848-9 –	20 MH	MP-930-9 –	20 MH	MP-395-9 –	86 MH	MP-254-9 –
24 MH	MP-206-10 –	10 MH	MP-848-10 –	24 MH	MP-930-10 –	24 MH	MP-395-10 –	100 MH	MP-254-10 –
30 MH	MP-206-11 –	12 MH	MP-848-11 –	30 MH	MP-930-11 –	30 MH	MP-395-11 –	120 MH	MP-254-11 –
36 MH	MP-206-12 –	15 MH	MP-848-12 –	36 MH	MP-930-12 –	36 MH	MP-395-12 –	150 MH	MP-254-12 –
43 MH	MP-206-13 –	17.5 MH	MP-848-13 –	43 MH	MP-930-13 –	43 MH	MP-395-13 –	175 MH	MP-254-13 –
50 MH	MP-206-14 –	20 MH	MP-848-14 –	50 MH	MP-930-14 –	50 MH	MP-395-14 –	200 MH	MP-254-14 –
60 MH	MP-206-15 –	24 MH	MP-848-15 –	60 MH	MP-930-15 –	60 MH	MP-395-15 –	240 MH	MP-254-15 –
72 MH	MP-206-16 –	30 MH	MP-848-16 –	72 MH	MP-930-16 –	72 MH	MP-395-16 –	300 MH	MP-254-16 –
86 MH	MP-206-17 –	36 MH	MP-848-17 –	86 MH	MP-930-17 –	86 MH	MP-395-17 –	360 MH	MP-254-17 –
100 MH	MP-206-18 –	43 MH	MP-848-18 –	100 MH	MP-930-18 –	100 MH	MP-395-18 –	430 MH	MP-254-18 –
120 MH	MP-206-19 –	50 MH	MP-848-19 –	120 MH	MP-930-19 –	120 MH	MP-395-19 –	500 MH	MP-254-19 –
150 MH	MP-206-20 –	60 MH	MP-848-20 –	150 MH	MP-930-20 –	150 MH	MP-395-20 –	600 MH	MP-254-20 –
175 MH	MP-206-21 –	72 MH	MP-848-21 –	175 MH	MP-930-21 –	175 MH	MP-395-21 –	720 MH	MP-254-21 –
200 MH	MP-206-22 –	86 MH	MP-848-22 –	200 MH	MP-930-22 –	200 MH	MP-395-22 –	860 MH	MP-254-22 –
240 MH	MP-206-23 –	100 MH	MP-848-23 –	240 MH	MP-930-23 –	240 MH	MP-395-23 –	1.00 HY	MP-254-23 –
300 MH	MP-206-24 –	120 MH	MP-848-24 –	300 MH	MP-930-24 –	300 MH	MP-395-24 –	1.20 HY	MP-254-24 –
360 MH	MP-206-25 –	150 MH	MP-848-25 –	360 MH	MP-930-25 –	360 MH	MP-395-25 –	1.50 HY	MP-254-25 –
430 MH	MP-206-26 –	175 MH	MP-848-26 –	430 MH	MP-930-26 –	430 MH	MP-395-26 –	1.75 HY	MP-254-26 –
500 MH	MP-206-27 –	200 MH	MP-848-27 –	500 MH	MP-930-27 –	500 MH	MP-395-27 –	2.00 HY	MP-254-27 –
600 MH	MP-206-28 –	240 MH	MP-848-28 –	600 MH	MP-930-28 –			2.40 HY	MP-254-28 –
720 MH	MP-206-29 –	300 MH	MP-848-29 –	720 MH	MP-930-29 –			3.00 HY	MP-254-29 –
860 MH	MP-206-30 –	360 MH	MP-848-30 –	860 MH	MP-930-30 –			3.60 HY	MP-254-30 –
1.00 HY	MP-206-31 –	430 MH	MP-848-31 –	1.00 HY	MP-930-31 –			4.30 HY	MP-254-31 –
1.20 HY	MP-206-32 –	500 MH	MP-848-32 –	1.20 HY	MP-930-32 –			5.00 HY	MP-254-32 –
1.50 HY	MP-206-33 –			1.50 HY	MP-930-33 –			6.00 HY	MP-254-33 –
1.75 HY	MP-206-34 –			1.75 HY	MP-930-34 –			7.20 HY	MP-254-34 –
2.00 HY	MP-206-35 –			2.00 HY	MP-930-35 –			8.60 HY	MP-254-35 –
2.40 HY	MP-206-36 –			2.40 HY	MP-930-36 –			10.0 HY	MP-254-36 –
3.00 HY	MP-206-37 –			3.00 HY	MP-930-37 –			12.0 HY	MP-254-37 –
				3.60 HY	MP-930-38 –			15.0 HY	MP-254-38 –
				4.30 HY	MP-930-39 –			17.5 HY	MP-254-39 –
				5.00 HY	MP-930-40 –			20.0 HY	MP-254-40 –
				6.00 HY	MP-930-41 –			24.0 HY	MP-254-41 –
				7.20 HY	MP-930-42 –			30.0 HY	MP-254-42 –
				8.6 HY	MP-930-43 –			36.0 HY	MP-254-43 –
				10.0 HY	MP-930-44 –				
				12.0 HY	MP-930-45 –				
				15.0 HY	MP-930-46 –				
				17.5 HY	MP-930-47 –				

IN ORDERING: Add suffix "A" to above numbers for clear bushing. Add suffix "B" to above numbers for tapped bushings.

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plates until they mesh exactly, then tightens an Allen screw on a flexible coupler attached to a large calibrated wheel. The rotor is turned out and again pushed back to meshing position with the brass plate; a vernier adjustment on the large wheel is adjusted to bring the dial scale to zero.

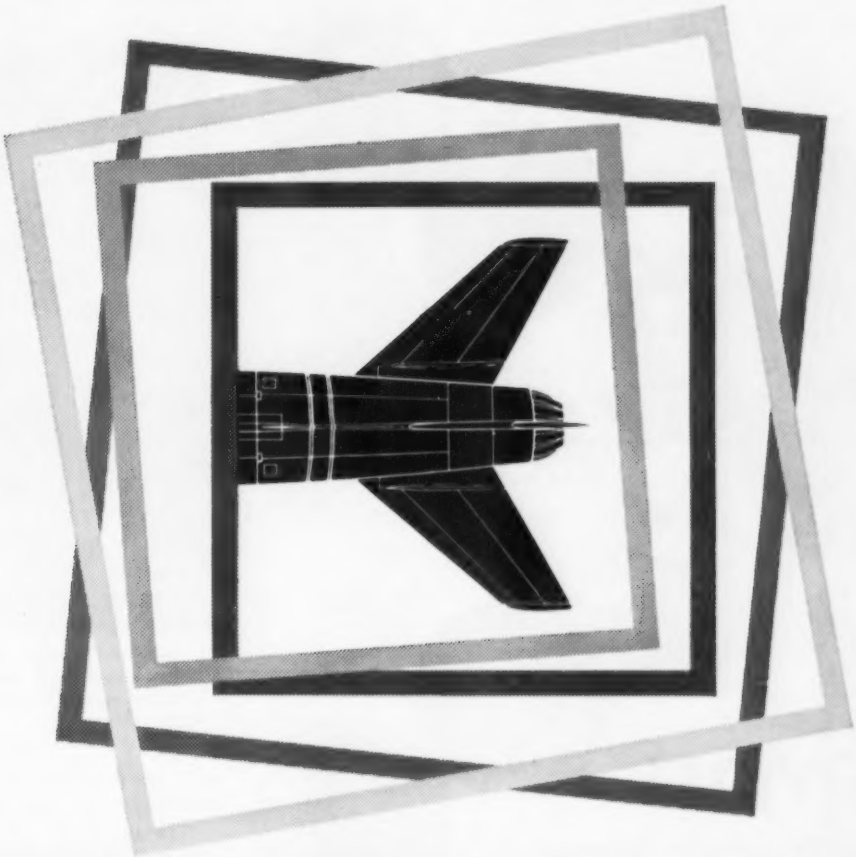
Operator sets large dial scale to desired new angular position with right hand and adjusts bridge with left hand to calibrate completed capacitor within tolerance of 0.02 micromicrofarad

Alligator-clip connections are then made from the test set to the stator terminals. The rotor is set to 95 percent of full capacitance and the appropriate serrated plate is adjusted to specified capacitance as measured with the capacitance bridge. The adjustment is repeated at the 5 percent setting, then for each additional 10 percent increment in between, for the first stator section. After rechecking at 5 and 95 percent, the entire procedure is repeated for each other section in turn.

A voltage breakdown test is performed between the rotor and each stator section in turn. If sparking occurs, the trouble is cleared either by burning it out or by appropriately bending the plates responsible for the sparking and the entire calibration is repeated.

Punch Press Guard

A CONVENIENT GUARD that protects fingers and still allows the operator to get close to the work is used on Benchmaster punch presses in the metal shop of Lenkurt Electric Co., San Carlos, Calif., in connection



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North American Aviation, Inc. is doing research and development on the X-15, a manned aircraft for investigation of speeds and temperatures at very high altitudes.

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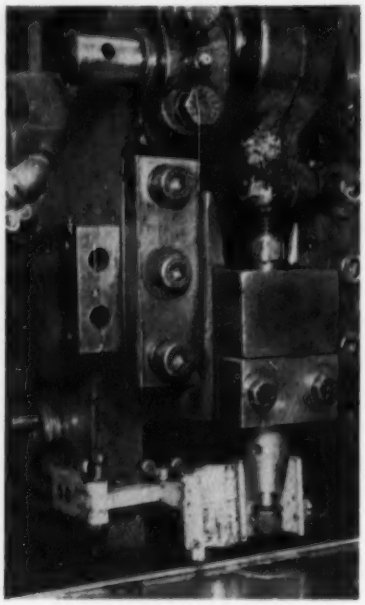


Hinged steel cylinder of guard closes around punch and holder. Tightening wing-nuts on double-elbow arm locks the guard in position

with the manufacture of carrier and microwave equipment.

The guard is a heavy steel cylinder split lengthwise and hinged to open. A mechanical latch holds it closed. It completely encloses the holder, punch, washer and stripper and reaches to within about ¼ inch of the table—too small a space for fingers to slip through.

The guard is mounted on a double-elbowed arm which in turn is firmly attached to the frame of the machine. The jointed arm permits rigid positioning of the guard by tightening wing-nuts at each elbow, yet permits swinging the guard completely out of the way when examining the work or changing the setup.

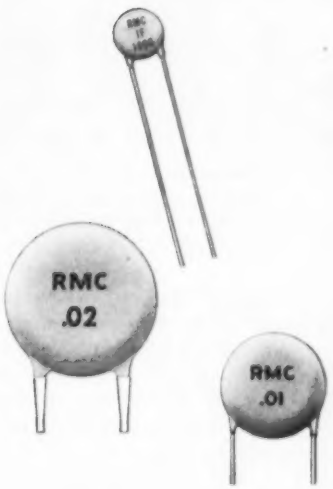
New Booster Pump Cuts Capacitor Drying Time

REDUCTION IN TIME required to evacuate moisture from tubular paper-foil capacitors—from 106 hours down to 30 hours—resulted from the installation of a 6-inch Stokes Ring-Jet booster pump in the drying and impregnating equipment of a Midwestern capacitor manufacturer.

High-voltage breakdown tests

when good enough is not enough...

specify RMC DISCAPS for the **ultimate**



If you want to improve the quality of your electrical or electronic product you will do well to investigate the advantages of RMC DISCAPS. Modern research methods and strict quality controls have made DISCAPS the outstanding ceramic capacitors for a wide range of applications.

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Want more information? Use post card on last page.

BOURNS now offers an expanded line of

TRIMPOTS®

...7 stock models of sub-miniature potentiometers to serve many special needs—at no extra cost!

First there's the 120 Wirewound TRIMPOT, with features common to all other BOURNS TRIMPOTS. It's a 25-turn potentiometer, easily adjusted, and weighing only 0.1 oz. Rectangular in shape, it fits readily into miniature electronic circuits. You can mount it individually, or stack it compactly with standard screws. Mountings are interchangeable with those on all other TRIMPOTS.

The self-locking shaft holds stable settings under extreme environmental conditions. All parts are corrosion resistant. Every unit is inspected 100% for guaranteed specifications. Resistances: 10 to 20,000 ohms, with resolutions as low as 0.2%.

Now, to give designers greater latitude, BOURNS has developed and is manufacturing the following standard models—variations of the Model 120.

120 TRIMPOT
—Carbon
Infinite resolution is provided by the carbon element. Resistances are higher, ranging from 20,000 ohms to 1 megohm.

130 TRIMPOT
—Solder Lug
For wiring direct to the instrument, using soldering iron or dip soldering techniques. Usable range of 98%.

132 TRIMR
—Variable Resistor
High resistances—up to 50,000 ohms in a wirewound rheostat.

209 TWINPOT
—Dual Potentiometer
Two outputs electrically independent, and controlled simultaneously by one adjustment.

160 TRIMPOT
—High Temperature
Operates at 175°C. High power rating: 0.6 watt at 50°C.

230 TRIMPOT
—Humidity-proof
Completely sealed, unit meets MIL-E-5272A Specifications for humidity.

Write for literature on the BOURNS TRIMPOT line.

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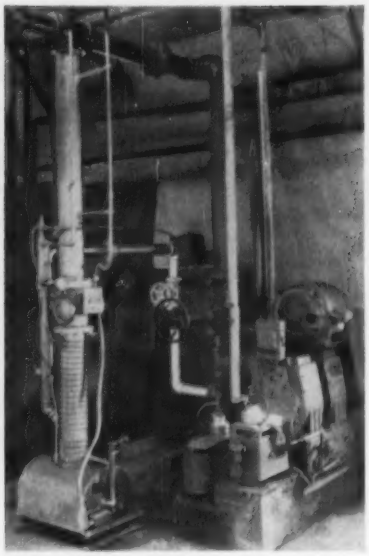
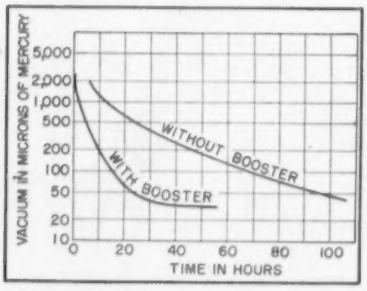


New 6-inch booster pump (left) used in combination with rotary mechanical vacuum pump



Comparison of paper capacitor impregnation cycles before and after installation of booster pump

showed that capacitors dried in the much shorter period were in every respect equal to or superior to those dried in the considerably longer period when only a mechanical vacuum pump was used to evacuate the system.

The moisture is removed by applying heat under a very high vacuum. This must be maintained for a prolonged period, since the only opening through which the water vapor can escape is a hole ¼ to ½ inch in diameter in the top of the welded steel case of the capacitor.

The new pumps have a ring of jets that replaces the jet cone of conventional diffusion and booster pumps. This ring of jets permits the cross-sectional area of the airflow path to be substantially in-

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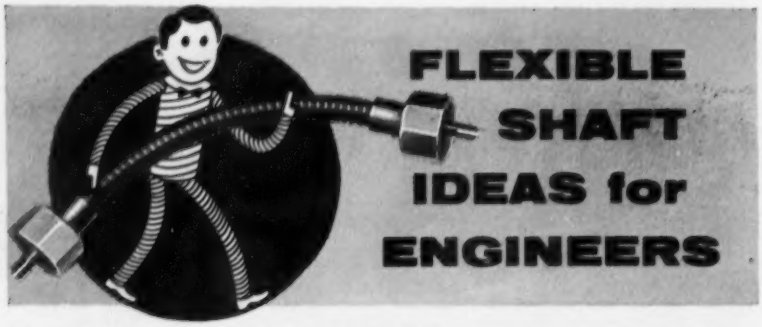
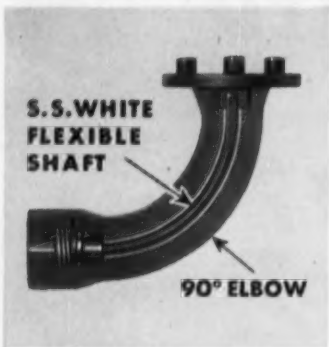
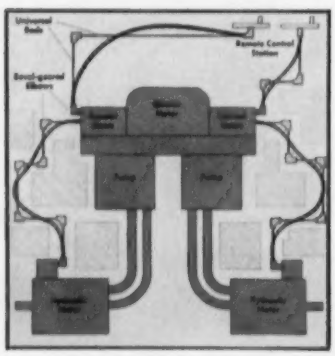


Flexible Shafts simplify manufacturing operations — lead to improved designs

Cost-savings possibilities are many when you design with these useful mechanical elements



A truck recorder drive in which a 3" flexible shaft replaced a set of bevel gears and straight shafts. Result: fewer parts, lower cost and elimination of failures caused by high starting torque of the gears.



4 standard flexible shafts replaced the 35 parts formerly used to control this dual hydraulic power unit. Result: a 90% cost savings and 100% improved performance.

NO OTHER SINGLE MECHANICAL ELEMENT solves power drive and remote control problems as simply and economically as an S.S.White flexible shaft.

Savings through Simplification

For instance, the ability of an S.S.White flexible shaft to operate around turns and under conditions of misalignment is a big help in simplifying drive or control setups. It means that a single flexible shaft can often be used in place of whole systems of bevel and worm gears, solid shafts, universals, etc. Naturally, with fewer parts to handle, production time and costs can be trimmed.

Improved Designs

Simplification is not the only advantage offered by an S.S.White flexible shaft. It gives greater leeway in locating coupled parts to insure greater efficiency, easier operation, greater compactness, or more attractive appearance.

Reduced Layout Time

Not the least of a flexible shaft's advantages, is the ease with which it can be applied. There are no gear ratios to work out—no alignment problems—no worries about tolerances on bearing and journal fits, about special machining, etc. And, the wide range of physical characteristics and sizes available, make it easy to meet a diversity of requirements.

Bulletin 5601 has details. Send for a copy.

FS-4A

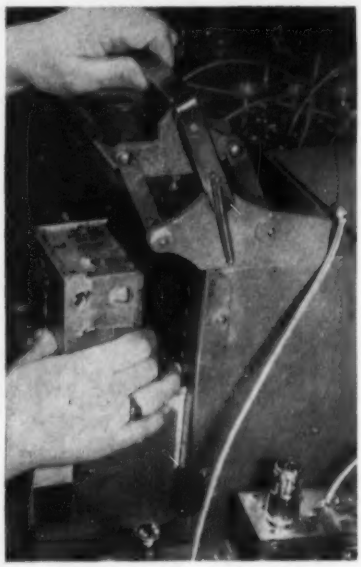
S.S.White FIRST NAME IN FLEXIBLE SHAFTS

S. S. WHITE INDUSTRIAL DIVISION, DEPT. E, 10 EAST 40th ST., NEW YORK 16, N.Y.

Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.

creased, thus greatly increasing the volume of air that can be passed through the pump and hence increasing its pumping speed.

Imprinting Fixture



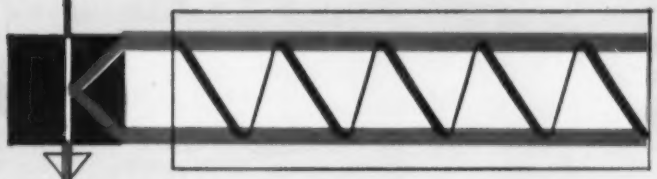
Swinging stamp-holding fixture up after making neat imprint on side of uhf tuner that is rigidly positioned between blocks of fixture

USE OF A HOLDING fixture with an automatically inked rubber stamp insures neatness and uniform location of the identifying imprint on each uhf tuner produced in the Camden, N. J. plant of Radio Condenser Co. The operator sets a tuner into position between wood blocks attached to the base of the stamping unit, then operates the lever that swings the stamp up from the pad and down onto the side of the tuner. With the parallelogram-type mounting arrangement, the stamp is moving essentially vertically as it comes down and as it is retracting, so that there is no smudging.

Ultrasonic Welding

POSSIBILITIES OF welding thin copper conductors ultrasonically at low temperature to aluminum and other chassis metals was recently demonstrated by Aeroprojects,

A REPORT FROM KELLOGG ON



KEL-F® Plastic GRADE 500

Results of electrical tests on Grade 500	
VOLTAGE BREAKDOWN	**VOLTS**
Initial volts	13,500
at 150°C.—1 week	13,000
2 weeks	14,600
at 175°C.—1 week	13,500
2 weeks	14,500
at 190°C.—1 week	11,300
2 weeks	9,600

New Fluorocarbon Plastic Formulation Provides Wire Insulation that can withstand Continuous Operating Temperature up to 175° C.

KEL-F PLASTIC, Grade 500—like all the molding compounds in the KEL-F fluorocarbon series—is notable for its extreme resistance to high temperatures, chemical attack, humidity and abrasion.

Of special interest to the electrical field is the higher heat-aging level of wire coatings with the new Grade 500. Tests on wire insulation indicate a continuous operating range of temperatures up to 175°C. Samples of coated wire exposed to temperatures as high as 190°C. for extended periods of time (2-3 months) still maintain relatively high voltage breakdown values.

Results of these electrical performance tests are summarized in the table above. An examination of the breakdown voltages after continuous exposure to high temperatures points up the high heat-aging level reached by KEL-F PLASTIC Grade 500 coated wire.

TWO TYPES AVAILABLE

KEL-F PLASTIC GRADE 500 is produced in two distinct types:

GRADE 500-F, a less crystalline type that resists embrittlement by high temperatures. Recommended for general wire and cable insulation, hook-up wire, thin wall tubing, and spaghetti.

GRADE 500-R, possesses same general properties as F type, only a slightly more rigid formulation. Recommended for use in connector insulation and for coil forms.

MOLDABILITY

The new Grade 500 permits extrusion of high molecular weight coatings and thin wall tubing that resist embrittlement when exposed to higher temperatures. Less crystalline in structure, Grade 500 can be fabricated without danger of splitting or crazing when heated. The flexibility of Grade 500 coated wire is also slightly improved.

TECHNICAL SERVICE

KEL-F PLASTIC Grade 500 is a result of Kellogg's comprehensive research in the field of fluorocarbon chemistry. Our technical staff will be happy to work with you in developing specific applications for the new Grade 500.

REPORT ON KEL-F PLASTIC, GRADE 500

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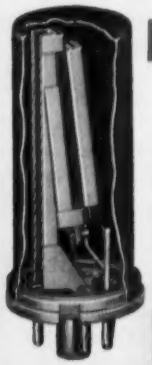

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G-V Red Dot Relays are available from stock for delays of 2 seconds to 3 minutes with heater voltages from 6.3 to 230 volts.

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Inc., West Chester, Pa. The two pieces of metal to be joined are clamped together by the electrodes of the ultrasonic welder and ultrasonic energy is applied to the thinner member by one of the electrodes. The resulting oscillatory motion is believed to cause breakup of the interface between the two metals, providing the intermolecular contact required for a true weld.

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At present, the process is restricted to welding thin foils (0.001 to 0.025 in.) to opposing pieces that do not greatly exceed 1 in. in thickness. Dissimilar metals can be welded if in the same hardness range. Continuing development work is gradually increasing the thickness limits.

Rubber Band Holds TV Cabinet Cover

DURING ASSEMBLY of color tv sets in their cabinets on the RCA assembly line in Bloomington, Ind., the removable top cover of each cabinet is taken off for convenience. To keep each cover with its cabinet

Stretching rubber band around color tv cabinet to hold top cover in position against padding on far side

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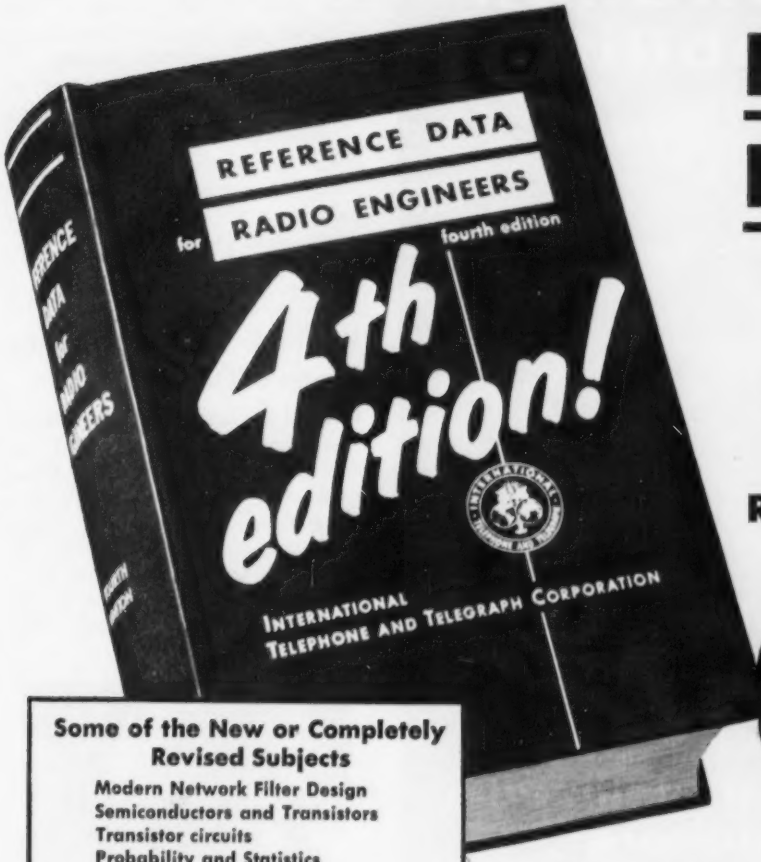

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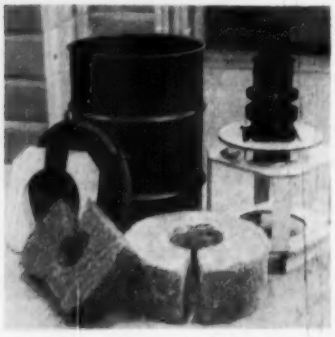
on the moving-slat conveyor line, protective padding is placed against one side of the cabinet. The polished top surface of the cover is faced against this padding. A large rubber band, cut from an automobile innertube, is then stretched around the cabinet to hold the cover in position. This procedure has practically eliminated damage to the finish of the cover during final assembly.

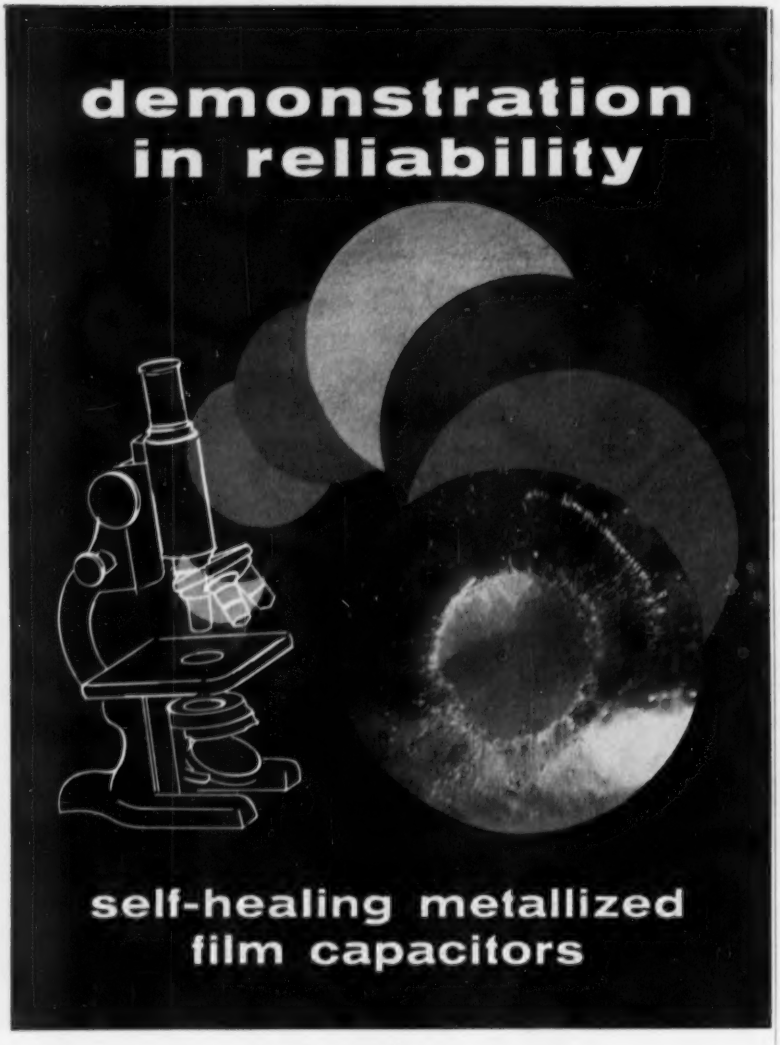
Rubberized Fiber Packing Protects Tube

CAREFULLY SUSPENDED in rubberized fiber and a wooden framework, the SAL-39 transmitting tube being made by the General Electric power-tube subdepartment meets rigid packing specifications for electron tubes made for the U. S. Government. When packed in the 28-gauge steel drum, the tube with-



Packing material and plywood cradle for metal-wall tube

Packed tube, ready to go in drum



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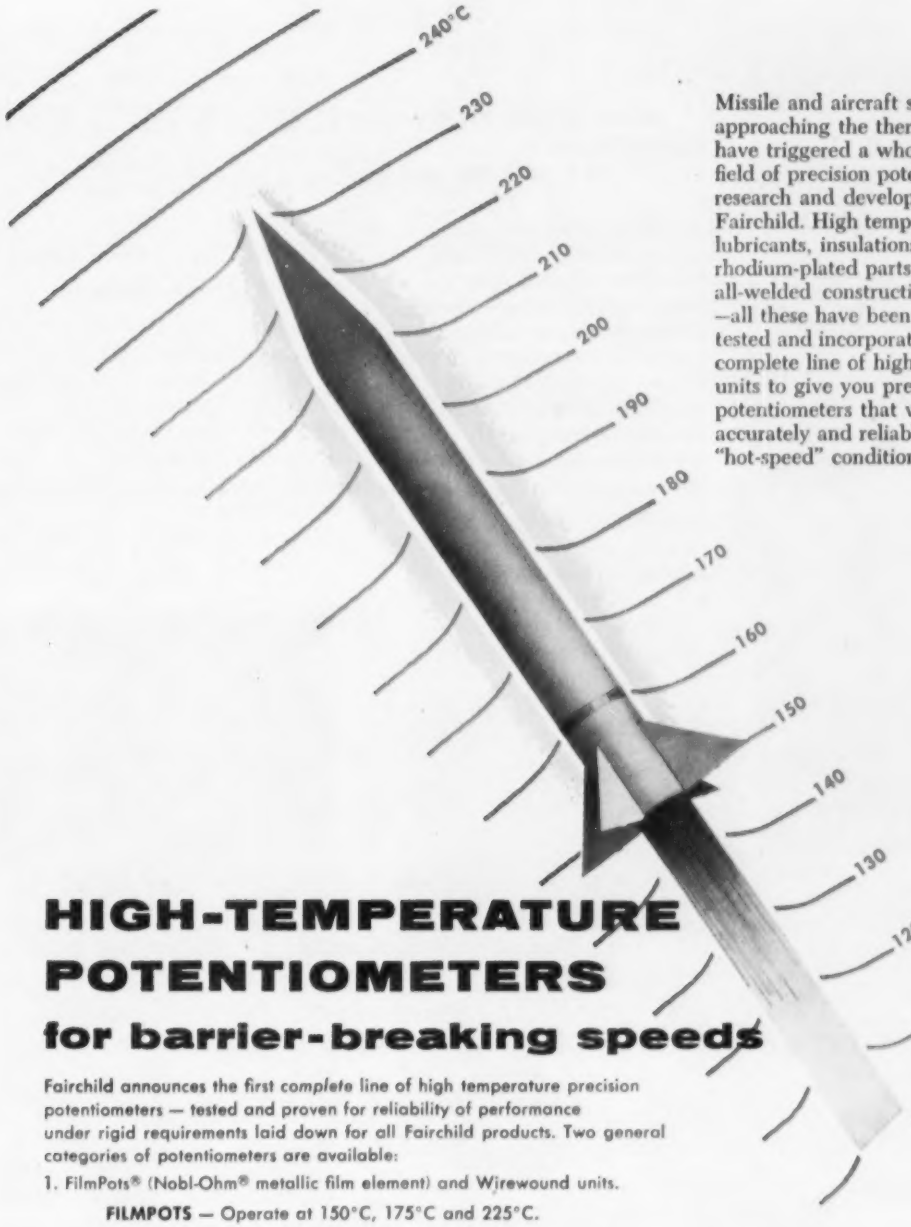

Missile and aircraft speeds approaching the thermal barrier have triggered a whole new field of precision potentiometer research and development at Fairchild. High temperature lubricants, insulations, solders, rhodium-plated parts, special all-welded construction techniques —all these have been designed, tested and incorporated into a complete line of high temperature units to give you precision potentiometers that will function accurately and reliably under "hot-speed" conditions.

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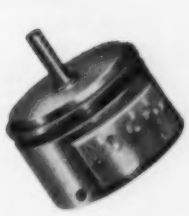
Fairchild components research, implemented by critical production techniques and severe testing programs, is continuing to develop units for even higher temperatures and can offer constructive cooperation in guided missile and aircraft control programs. For data sheets, or for assistance on specific problems, write to Fairchild Controls Corporation, Components Division, Dept. 140-72A1.



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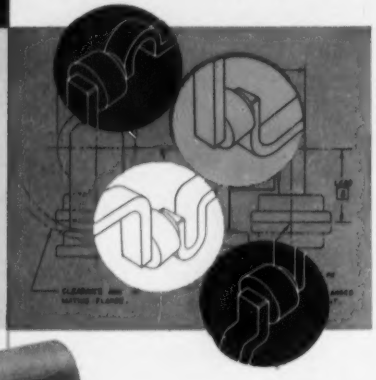

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Pushbutton Tuner Lever Assembly Techniques

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First step in assembling slide for cam-and-lever type auto radio pushbutton tuner involves loading two parts into pass-along fixture

► **Manual Pass-Along**—A special holding fixture is used in connection with manual pass-along at a three-operator setup to insure precise positioning of three slide parts that are to be riveted together. The first operator drops a brass spring into the fixture, then

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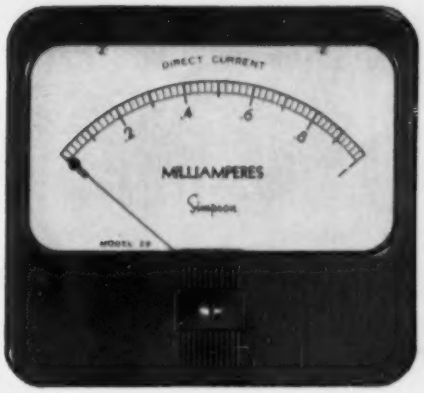

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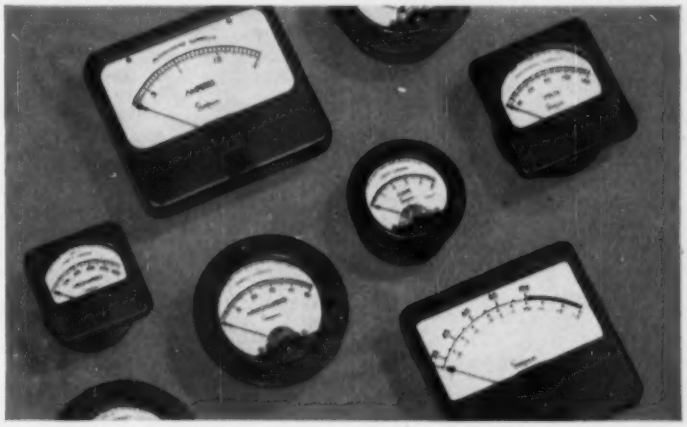

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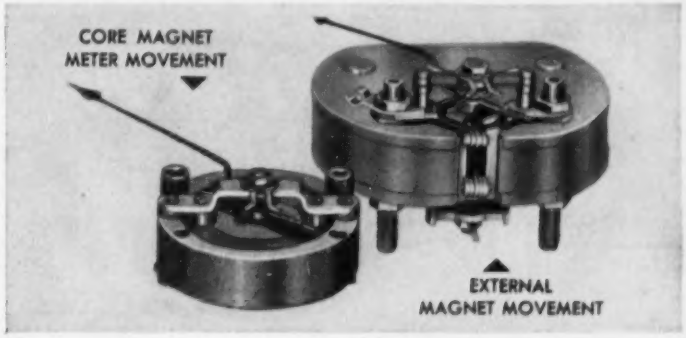

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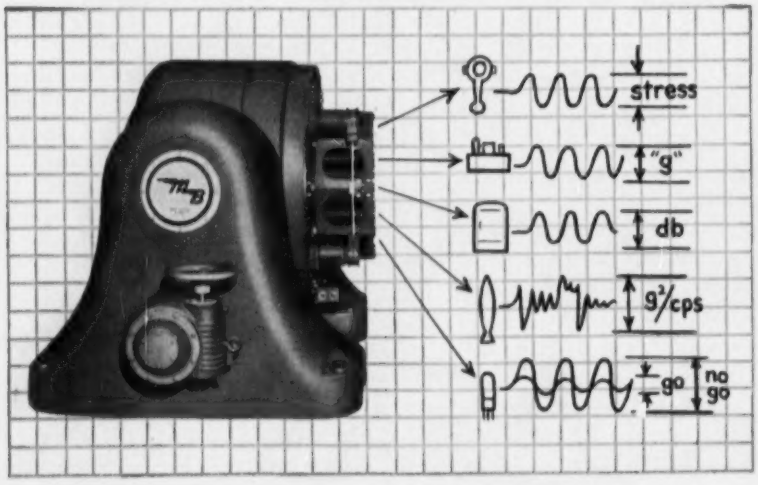
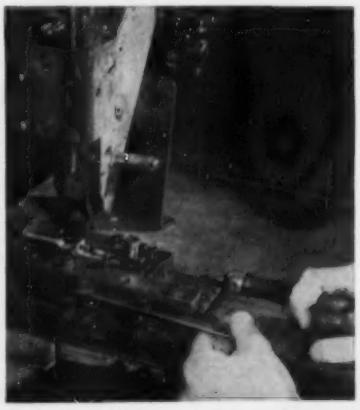


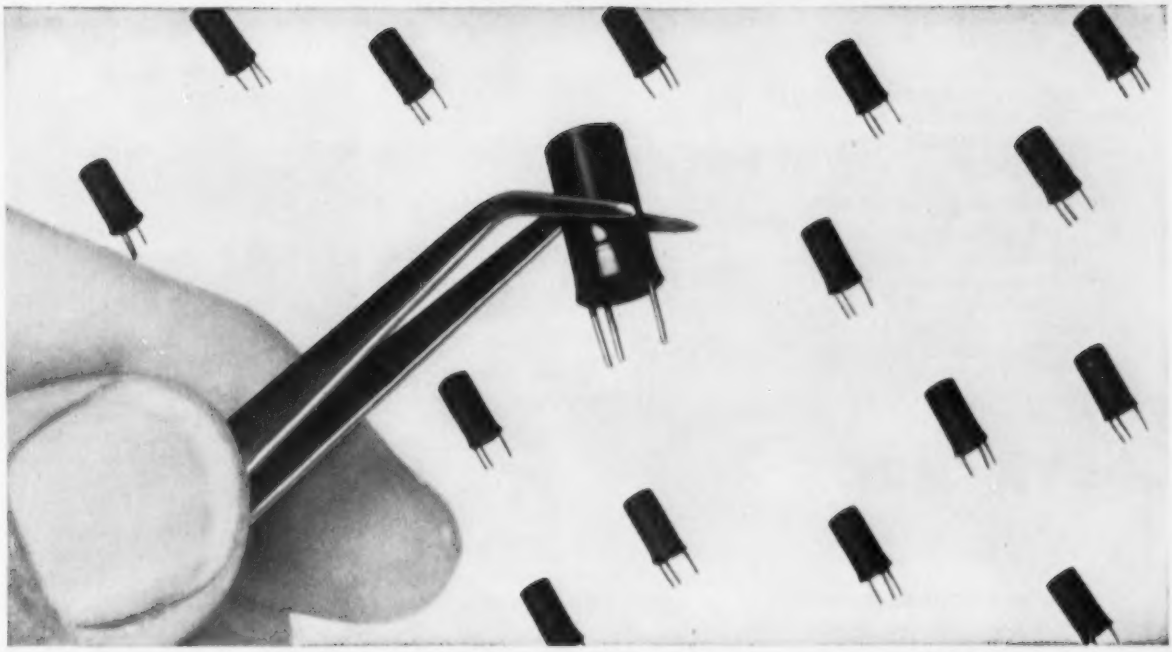
places the slide on positioning pegs over the spring. She then slides the fixture along a circular table to the second operator who places a black spring on top of the slide and sets a hold-down cam that locks the assembly together.

The fixture is then passed to the third operator at the riveter, who grasps the fixture by a wood handle projecting from one end and slides it against a precision stop on the table under the riveter. After inserting the first rivet, she operates a lever attached to the table to change the position of the stop so the fixture can be pushed to the second position for insertion of

Turning hold-down cam after placing black locking lever spring over slide



Holding pass-along fixture in position under riveter



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the last rivet. She then unloads the fixture and slides the empty fixture across the diameter of the table to the first operator.

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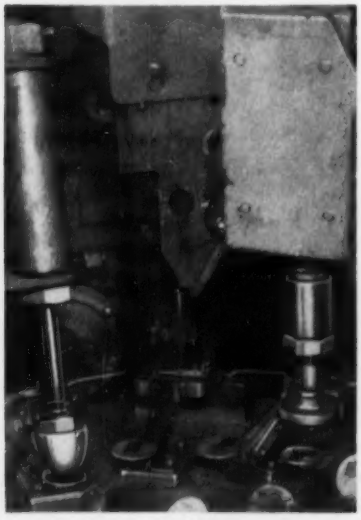

Air cylinder at left pushes actuating lever of dog down to lock parts in position. After riveting, air cylinder at right, having disk on end of shaft, pulls up locking lever to release assembly

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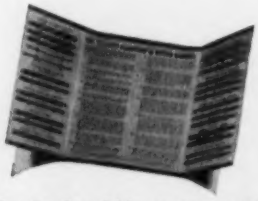

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Makers of Electrical Insulating Tubing and Sleeving

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(For Silicone Products Only)

Please send me free folder containing samples of your electrical insulating tubing and sleeving.
I am particularly interested in insulation for _____

Name _____
Company _____
Street _____
City _____ Zone _____ State _____

finger that closes a hold-down dog over the assembly. Two separate riveting machines operate in sequence at the next two positions. An air cylinder then pulls up the locking lever to release the assembly, and an ejection finger pushes the assembly down a chute.

▶ **Conveyorization**—A color-coded conveyor belt running down the middle of the assembly bench transfers assemblies to the riveting press for the final asembly opera-

Color-coded conveyor setup used in final assembly of cam and locking lever on slide. Conveyor brings assemblies to press operator at left rear

Method of transferring assemblies from end of conveyor to fixtures on automatically indexing turntable of press

SENSITIVE RESEARCH INSTRUMENT CORP.

The greatest advancement in electrical indicating instruments in the past decade...

THE TETRAD DIAMOND PIVOT

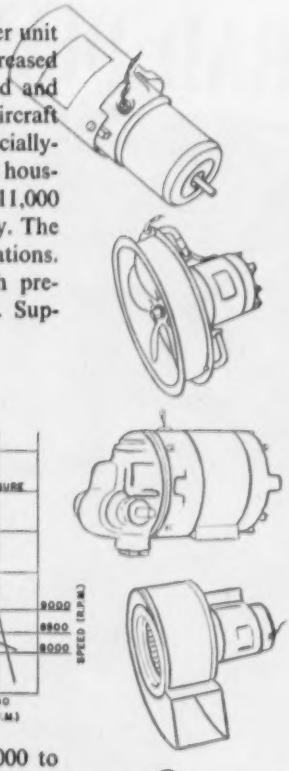
S M T T A B T

TETRAD

Dept. 5-T. 62 ST. MARY STREET, YONKERS, N. Y.

Manufacturer of
DIAMOND PRODUCTS
Pivots — Styli — Engravers —
Gauge and Embossing Points

IMC'S new BC 2914 F-1 is a compact fan-blower unit for airborne application which provides increased blower speeds at lower air densities. Developed and manufactured originally for use in military aircraft instrumentation, the BC 2914 F-1 features a specially-designed lightweight cast aluminum impeller and housing. At 60,000 feet, blower speed is increased to 11,000 rpm, with corresponding increase in air delivery. The BC 2914 F-1 meets all JAN and MIL specifications. Rotating parts are dynamically balanced with precision shielded ball bearings used throughout. Supplied with either AC or DC motor.



SPECIFICATIONS · BC 2914 F-1

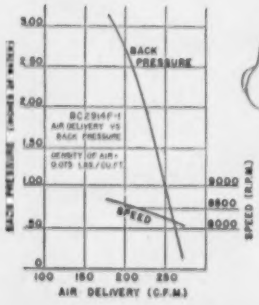
115 volts at 2.5 amps

1/6 hp

400 cycles

Single phase

Weight: 5 lbs., 6 oz.



Request information on other units from 1/1000 to 1/10 hp in the IMC line of AC and DC subfractional, servo and gear motors, fans, blowers and dynamotors.

Induction Motors Corp.

370 Main St., Westbury, L. I., N. Y. • Phone EDgewood 4-7070

tions on the pushbutton slide arm. The four workers along this line are each assigned one of the four colors used to divide up the belt. Each operator does exactly the same operation and places her assembled group of parts on the panel having her assigned color on the belt. This assures that every panel will be filled and the assemblies will reach the press operator at the end of the conveyor with exactly uniform spacing.

The press operator transfers the assemblies one by one from the belt to fixtures on the automatically indexing turntable of the press. In sequence, the press curls the cam rivet, sizes the fulcrum, sizes the extension sideways to reduce play, lubricates the slide and then ejects the finished assembly into a bin at the rear. When the press is shut off, the belt stops automatically to prevent pileups.

Luggage Clips Hold Units

Pushing down luggage clip to anchor chassis on holding fixture

SIMPLE WOOD FRAMES using luggage clips as hold-down clamps support modular chassis units during assembly work in the Long Island City plant of Ford Instrument Co. The fixture provides ample clearance for rods that project down from the chassis.

The ends of the wire loops of the luggage clips are bent at right angles with pliers.

PYRAMID technical bulletin

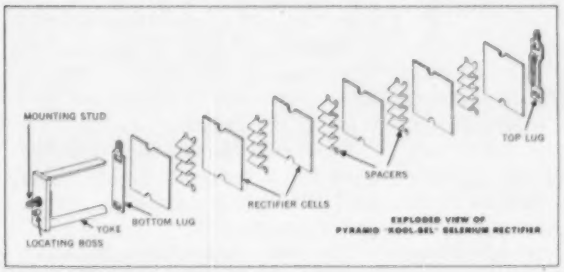
NO.66

SELENIUM RECTIFIERS

General:

The trend toward component miniaturization with attendent increase in equipment compactness has resulted in a steadily rising ambient operating temperature. Selenium rectifiers are particularly critical in this respect because much depends on their ability to maintain a high output voltage over extended periods of time. A major limiting factor in this respect has been the "Center-support" type of construction of conventional rectifiers and the tendency of this construction to concentrate the generated heat within a relatively small area. The Pyramid patented-type construction, known as the "Kool-sel," is a significant break-through of this heat barrier.

An exploded view of a Pyramid rectifier is shown below. Note that the center support has been eliminated completely; instead, the individual selenium rectifier coils are supported at their outer edges. A molded phenolic yoke forms the main supporting member, with a mounting stud and locating boss molded into the yoke. In this way, they become integral parts of that yoke. The lugs of the rectifier are slotted to accommodate the two arms of the yoke and the rectifier cells and spacers are notched to fit snugly on the yoke arms. Clinching lips are provided on the top lug so that when it is pressed on the yoke, all components are locked together to form a rigid assembly. During assembly, the spacers are flexed slightly to insure that the unit remains tight under all normal environmental conditions.



EXPLODED VIEW OF PYRAMID "KOOL-SEL" SELENIUM RECTIFIER

ADVANTAGES OF "Kool-sel" CONSTRUCTION:

Mechanical:

1. Cells and lugs are locked in place and cannot rotate.
2. Locking together of the components is accomplished without the current pickup contacts exerting excessive pressures on the cell counter electrode. Too much pressure may produce three detrimental effects: First, it may decrease the reverse resistance and thereby lower rectifier efficiency. Second, there is a cold flow of the counter electrode from under the pickup contacts. Third, fracture or damage to the counter electrode adjacent to the pickup contacts may occur.
3. The locating boss, being an integral part of the yoke, is always in the correct position.
4. Pulling on the positive lug cannot crack or break the alley (counter electrode) of the adjacent rectifier cell.
5. This particular mechanical construction results in fewer component parts.

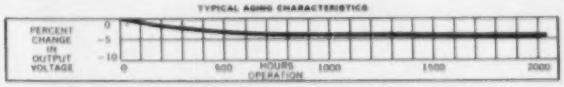
Electrical:

1. There is a high dielectric strength between the "live" components (i.e., cells, spacers, and lugs) and the mounting stud. The normal insulation thickness over the mounting stud is ¼".
2. There is high resistance to burnouts on current surges.
3. The current pickup points are distributed over the full width of the rectifier cell. This means that heat is dissipated rapidly and the temperature rise of the rectifier cells during the flow of current surges is relatively low.

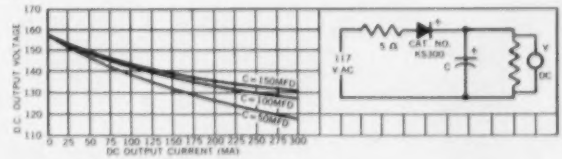
CHARACTERISTICS:

Illustrated below is a typical aging Characteristics Chart, showing percentage change in output voltage vs hours of operation.

CATALOG NUMBER	KS-65	KS-75	KS-100	KS-150	KS-200	KS-250	KS-300	KS-350	KS-400	KS-500
Maximum RMS Input Voltage	130	130	130	130	130	130	130	130	130	130
Maximum Inverse Peak Voltage	380	380	380	380	380	380	380	380	380	380
Maximum Peak Current (MA)	650	750	1000	1500	2000	2500	3000	3500	4000	5000
Maximum RMS Current (MA)	162	187	250	375	500	625	750	875	1000	1250
Maximum DC Current (MA)	65	75	100	150	200	250	300	350	400	500
Approximate Rectifier Voltage Drop	5	5	5	5	5	5	5	5	5	5
Minimum Series Resistance	22	22	22	10	5	5	5	5	5	5
Maximum Operating Plate Temperature	85°C	85°C	85°C	85°C	85°C	85°C	85°C	85°C	85°C	85°C



Voltage Regulation: The voltage regulation curves for a 300 ma selenium rectifier in a half-wave circuit with 117-volt rms input shown below. Suitable voltage regulation curves for all Pyramid "Kool-sel" selenium rectifiers are available upon request.



APPLICATIONS:

Radios and Radio-Phonographs: Low-cost, efficient rectifiers for radios and radio-phonograph combinations are "Kool-sel" KS-65, KS-75, and KS-150. The needs of most 5-tube chassis are met by the KS-65, while the KS-75 and KS-150 are used in sets with larger current requirements.

Television Receivers: High-voltage power supplies in television receivers—including color sets—use "Kool-sel" numbers KS-200, KS-250, KS-300, KS-350, KS-400, and KS-500. These rectifiers, used in voltage doubler or voltage tripler circuits provide the proper B-plus voltage, eliminating the size, cost, weight and hum problems of power transformers. "U" shaped brackets are available which permit the rectifiers to be mounted either in vertical or horizontal positions.

Radio Accessories: TV boosters, UHF converters, phonograph oscillators, inter-coms and the like can usually be powered suitably by a "Kool-sel" KS-65 rectifier.

Laboratory Instruments, Power Supplies, Amplifiers: Rectified high voltage through the use of voltage doubler and tripler circuits, for equipment where current requirements run as high as 500 ma, may be provided with "Kool-sel" rectifiers. Types KS-200 through KS-500 will be found useful for laboratory power supplies, DC filament supplies, motion picture projectors, amplifiers, test equipment and other specialized uses.

FOR COMPLETE DATA SEND FOR ENGINEERING BULLETIN—FORM KS-1

PYRAMID ELECTRIC CO. North Bergen, New Jersey

PYRAMID IS THE BIG NAME IN CAPACITORS AND SELENIUM RECTIFIERS TODAY!

New Products

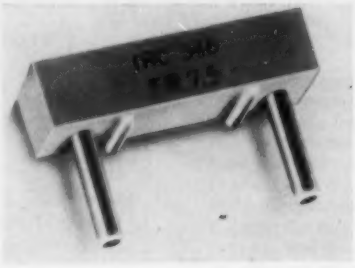
Edited by WILLIAM P. O'BRIEN

64 New Products and 67 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

FUSE RESISTOR

easily plugged into receptacle

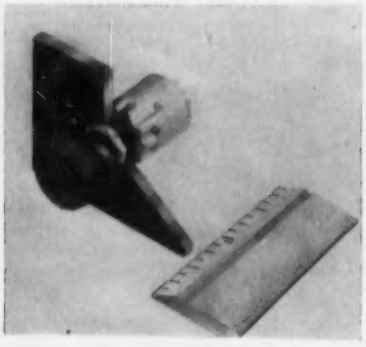
INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia 8, Pa., offers a new, completely insulated type FR fuse resistor, which functions as a resistor under normal conditions and as a fuse under abnormal conditions. It supplies the need for a small, compact, fully-insulated resistor-fuse combination that can be easily plugged into a receptacle. Its unique construction provides mechanical strength and simplicity of the complete unit.



The type FR also prevents overloading of more valuable components and possible fire due to short circuit in tv sets. It is particularly recommended as a surge-limiting resistor in voltage doubler circuits for tv receivers. Bulletin P-3 is available. **Circle P1 inside back cover.**

TAP SWITCH

is hermetically sealed



FARNSWORTH ELECTRONICS CO., Pacific Division, 815 San Antonio Road, Palo Alto, Calif., announces a new hermetically sealed switch designed to meet the increasing demands for reliability in electronic equipment. It features rigid, simplified mechanical design making use of low-loss glass insulation, solid molybdenum contact points, solid coined-silver contact arm, hardened shafts and wear surfaces.

The switch is rated at 3 amperes at 115 v inductive load, and withstands 5 g vibrations from 5 to 2,000 cps. It may be operated at temperatures as high as 350 F without damage to functional portions of the switch.

When panel mounted, it fills the need for a compact, highly rated switch which is explosion, splash and drip proof.

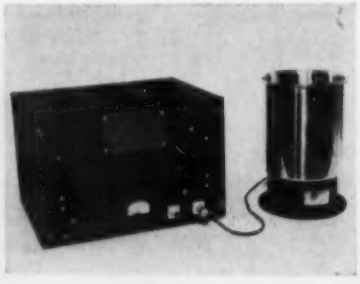
The switch is available in a variety of terminal designs and for a variety of mountings. Bulletin M1 contains detailed engineering data. **Circle P2 inside back cover.**

ULTRASONIC CLEANER

for lab or production use

ALCAR INSTRUMENTS, INC., 17 Industrial Ave., Little Ferry, N. J., has developed a low-frequency ultrasonic cleaner for small parts cleaning, blind hole washing, removal of radioactive contamination, printed circuit cleaning and other difficult cleaning operations.

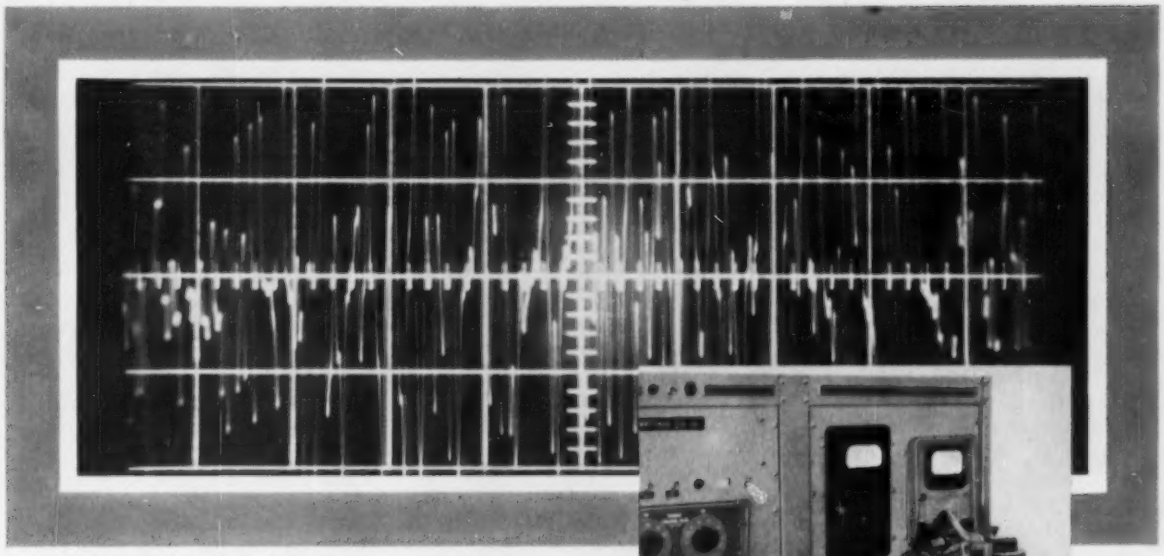
The standard unit consists of an electronic generator delivering up to 100 w of energy to crystal transducers mounted on a one-gallon stainless steel tank. Price is $475. **Circle P3 inside back cover.**



FURNACES

for crystal pulling

NRC EQUIPMENT CORP., 160 Charlemont St., Newton Highlands 61, Mass. Semiconductor manufacturers are offered two new low

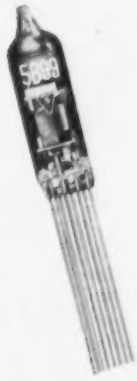


Unretouched oscillogram demonstrates the wide spectrum and random nature of vibrations inherent in Sylvania's new "white noise" vibration test. Its approximation of flight conditions to which guided missiles are subjected is an important contribution to tube reliability.

The "white noise" test rack is compact and simple to operate. It provides direct noise output readings from both an R.M.S. and a peak-to-peak voltmeter across a wide frequency spectrum.

"White Noise"

puts wings on a test rack, advances tube reliability



By providing a more realistic tube vibration test which can be adapted to large-scale production techniques, the "white noise" vibration test is contributing to greater tube reliability.

Developed by Sylvania engineers in conjunction with Naval contracts, the "white noise" vibration test meets important requirements for testing tubes used in guided missiles and other vehicular applications.

First, it simulates environmental conditions by presenting a wide range of vibrational frequencies. Secondly, it presents these frequencies at random g-levels. Thirdly, it provides specification limits through direct meter readings.

If you are interested in additional analysis of the "white noise" vibration test, write on your company letterhead. Please address Department L20P.

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
Shell Tower Bldg., Montreal
Eastern Hemisphere—Sylvania International Corp.
22 Bahnhofstrasse, Coire, Switzerland

LIGHTING · RADIO · TELEVISION · ELECTRONICS · ATOMIC ENERGY

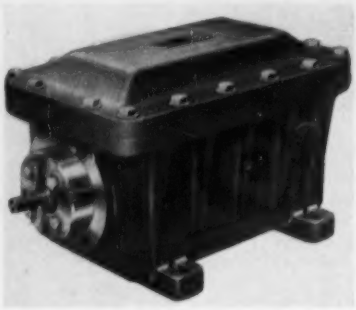
cost crystal pulling furnaces. The compact model 2995 vertical type and model 2996 horizontal type can be used to grow either germanium or silicon crystals.

These new standard units are equally suited for production or research. Both models are easy to load, unload and clean. They offer excellent visibility of the melting surface. High quality crystals are assured by close temperature control and a vibration-free, precision pulling mechanism driven by a variable speed motor. Both units are readily adaptable to automatic operation. **Circle P4 inside back cover.**

TACHOMETER PICKUP

an explosion-proof unit

I-L-S Instrument Corp., 10701 Briggs Road, Cleveland 11, Ohio. Model 2000AG explosion-proof tachometer pickup is a dual signal generating device which provides electrical impulses for operation of digital electronic counters and a 3-phase self-generated electrical output for powering a 3-phase synchronous electric tachometer indicator.



The two signal systems were incorporated into an integral unit to satisfy the demand for pointer type indications concurrent with precise digital information.

Model 2000AG is UL listed (Telemetering Transmitters) for installation in Class 1 Group D Hazardous Locations.

Standard units are available with 60 or 120 impulses per revolution and special models may be obtained with from 3 to 240 impulses per revolution. Bulletin TP-2000 is available. **Circle P5 inside back cover.**

WAVEFORM GENERATOR

transistorized, self-powered

Cubic Corp., 5575 Kearny Villa Rd., San Diego 11, Calif. Model 500 waveform generator is the first of a line of fully-transistorized, battery-powered test equipment. The instrument provides clipped saw-tooth and rectangular waveform output with a variable repetition rate from 10 cps to 50 kc. A square-wave output is available from 5 cps through 25 kc. With one change in a capacitor, these repetition rates may be reduced to one every 5 sec.

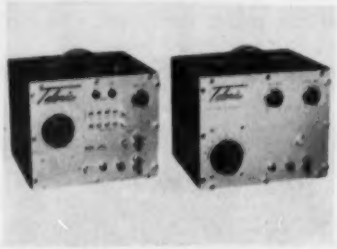
At full battery voltage an output of 7 v at 2,000 ohms impedance is available. The rectangular wave shape is continuously variable in pulse width from 5 to in excess of 200 μsec. With a total power drain of 300 mw, the anticipated life of the 22½-v battery is better than 500 hr. As the battery output drops off, there is no deterioriation in wave shape or stability, and only the output drops off. The unit has been operated through a temperature range of −40 to 160 deg with complete reliability. Price of the unit described is $135. **Circle P6 inside back cover.**

TV SWEEP GENERATOR

for production, engineering

Telonic Industries, Beech Grove, Ind. A new series sweep generator is available in two types, for both vhf and uhf tv use.

The vhf units feature electronic sweep, 1-v output and 25-mc sweep width. They cover channels 2-13 mc and i-f, and have crystal controlled markers on each channel. Designed with production line efficiency in mind, regularly used controls are mounted on the front panel; other adjustments are available at the rear.



The uhf type units cover a frequency range of 460-910 mc, with a sweep width of 0-50 mc. Output is 1 v into 50 ohms. Both types are flat within 5 percent.

Telonic Industries will work with you on any individual design problem. **Circle P7 inside back cover.**

SCALERS

completely transistorized

LaRoe Instruments, Inc., P. O. Box 5906, Bethesda 14, Md., announces the Transcaler series, a line of completely transistorized

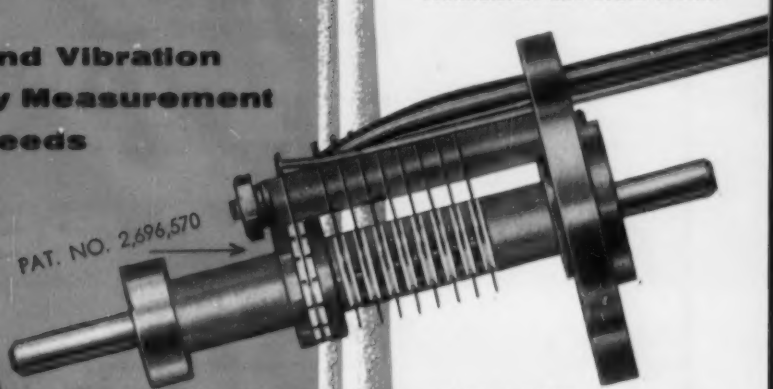
For ACCURATE HIGH SPEED SWITCHING..

Specify ELECTRO TEC

miniature ultra-low torque Precision Selector Switch

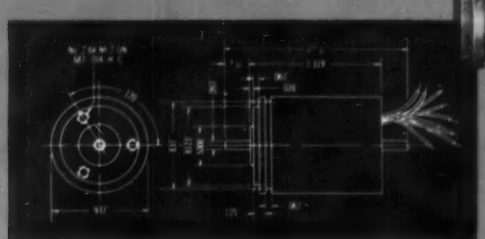
- Withstands Shock and Vibration
- Offers High Accuracy Measurement
- Operates at High Speeds

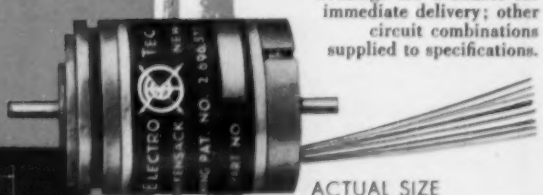
This new Electro Tec Precision Selector Switch is ideal where miniature size, low friction torque, high accuracy, and low electrical noise at high speeds are requirements. Simplified circuits and long service life recommend it for a wide variety of uses including sampling, pulse generation for precision measurement, telemetering and strain gage applications, in aircraft, missiles, servos, computors, etc. Switch design incorporates many exclusive features that have gained industry-wide acclaim for Electro Tec precision slip rings, commutators and brush blocks.



CALL OR WRITE FOR ILLUSTRATED BROCHURE

8 or 10 position switches in standard size 10 synchro housings are available for immediate delivery; other circuit combinations supplied to specifications.





ACTUAL SIZE

Electro Tec Corp.
SO. HACKENSACK
NEW JERSEY
Tel.: HUbbard 7-4540

pioneers in tubeless and transistor designs

- All-Transistor Designs
- High Conversion Efficiency
- Low Heat Dissipation
- Instant Warm-up Time
- Fast Transient Response
- Small Size, Light Weight
- Non-Microphonic Operation
- Stable, Rugged, Long Life

MINIATURE TRANSISTORIZED POWER PACKS

These transistorized "TRANSPACS"® supply a rugged, reliable, stable source of DC power, ideally suited for guided missile circuits, computer units, reference applications, and all types of miniature and standard size electronic devices.

Incorporates special circuitry with germanium junction diode rectification, high efficiency filtering, and germanium transistor regulation control. These tubeless models make obsolete the bulky, low efficiency, high heat vacuum tube or magnetic amplifier equivalents, wherever used.

Standard Models

Input 105-125 VAC, 60 or 400 cps. Input regulation within ±0.5%. Load regulation within ±0.5%. Ripple less than 0.05%. Units are potted in hermetically sealed transformer type housings, but transistors are replaceable.

Model No.	Output Volts	Current Ma	Case Size* 60 Cps	Case Size* 400 Cps	Weight-Lbs. 60 Cps	Weight-Lbs. 400 Cps	Net Price 60 Cycle	400 Cycle Net Price
TR5	5	0-200	D	C	1.7	1.5	$70.00	$95.00
TR10	10	0-200	D	C	1.7	1.5	70.00	95.00
TR20	20	0-200	D	C	1.7	1.5	70.00	95.00
TR30	30	0-150	D	C	2.7	1.7	70.00	95.00
TR40	40	0-150	D	C	2.7	1.7	70.00	95.00
TR50	50	0-150	D	C	2.7	1.7	75.00	95.00
TR100	100	0-100	E	D	4.5	2.7	90.00	110.00
TR150	150	0-100	E	D	4.5	2.7	90.00	110.00
TR200	200	0-100	F	E	5.7	4.5	115.00	150.00
TR300	300	0-100	F	E	5.9	4.5	120.00	160.00

* "C" case, 2 3/8 x 2 15/16 x 3 13/16 inches
* "D" case, 2 5/8 x 3 1/16 x 4 1/4 inches
* "E" case, 3 1/16 x 3 9/16 x 4 7/8 inches
* "F" case, 3 7/8 x 3 7/8 x 4 3/4 inches
(WxDxH)

(R) Trade Mark Registered

Transistorized "TRANSPACS" (R) are available in a variety of both fixed and adjustable voltage models. Also special models designed to customer specifications. Write for catalogue E200.

ERA Electronic Research Associates, Inc.

67 E. Centre Street
Nutley 10, New Jersey NUtley 2-5410

scalers and counters for laboratory and field use. The instruments range from a basic scale-of-128 unit to 1-mc decade units. Use of transistors gives such features as light weight, small size and low power drains.

Automatic count-up, count-down circuitry is included in some models to be used as reversing counters or in any problem where an automatic tally of difference between pulses of opposite polarity is needed.

Model 7002-A, the basic model of the series, features 0.7 μsec pulse pair resolution, a mechanical totalizer, manual selection of input pulse polarity and ability to operate more than 150 hours off an optional self-contained battery supply. Other models include 100,000 pps decade modules and four decade units as well as 1 mc units. Prices start at $475 for the model 7002-A. For full details write to the company.

CONSTANT MISMATCH
for coaxial line use

RADAR DESIGN CORP., 210 Fifth Ave., New York 16, N. Y. Model RDL-2 coaxial constant mismatch is featured in a new line of coaxial

Gear teeth get in line when he takes a hand

R. L. Thoen, right, explains faulty tooth conformation on a minute gear which has been enlarged 100 times in this king-sized projector. Gear specialist on the engineering staff of the Mechanical Division of General Mills and author of numerous technical papers, Thoen makes gear trains perform with uncanny accuracy. He helps design and build the special machines which make such accuracy routine work at the highly specialized plant.

Next to its men, General Mills is most proud of its machines. For it is this combination that mass produces gear trains with nearly imperceptible backlash, total cumulative error of 0.0002 inch, angular tolerances within 40 seconds of arc, positioning accuracy within 0.01 percent.

This typical General Mills precision production is possible only because men like Thoen have improved standard tools, created special machines, devised ingenious attachments. Some equipment is operated under strict temperature-humidity control. All is backed with the finest inspection devices. You can use these machines and the men that created and operate them to produce your precision products. You'll profit. A simple request brings more facts.

Booklet Tells More—Send Today

Learn how our men and machines eliminate irksome production problems. Write Dept. EL11, Mechanical Division of General Mills, 1620 Central Ave. N.E., Minneapolis 13, Minn.

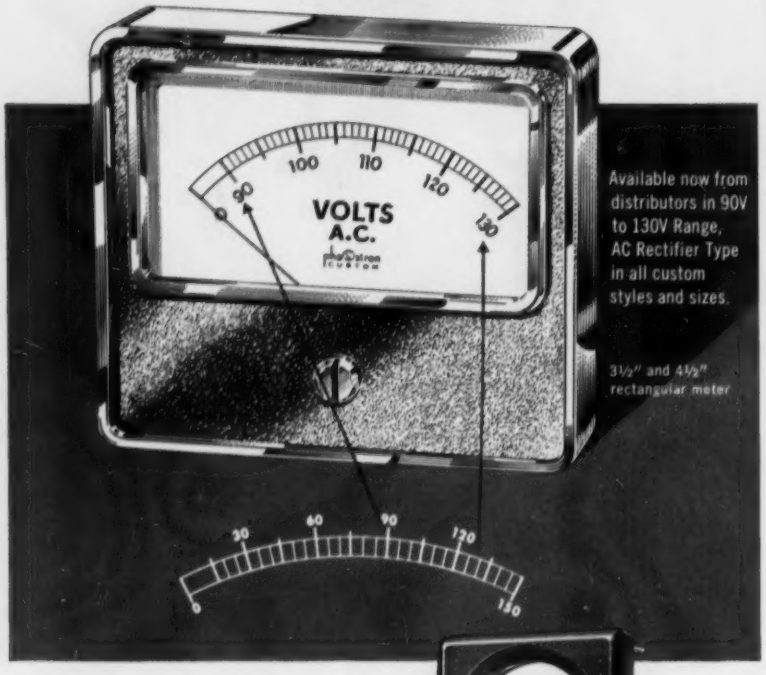
General Mills Pioneers Scientific Frontiers One of General Mills' numerous research projects involves the behavior of metals in space flight. Here a scientist determines the "sputtering" or disintegration rate of molybdenum at 200 miles above the earth. The metal is under fire from atoms moving at 25,000 m.p.h.

MECHANICAL DIVISION OF General Mills

CREATIVE RESEARCH AND DEVELOPMENT + PRECISION ENGINEERING AND PRODUCTION

NEW PHAOSTRON

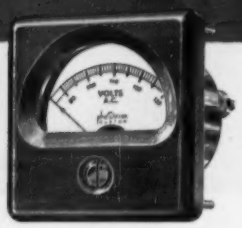
EXPANDED SCALE AC Voltmeter



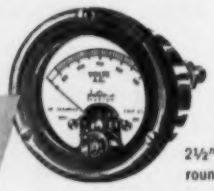
NOW!... all the time-tested proven Phaostron features... PLUS UP TO TEN TIMES GREATER READABILITY for greatly increased accuracy!

Phaostron has squeezed down that under 90V portion of the scale, where you don't need it, and expanded the section where you need it most — between 90 and 130V. Precisely calibrated 1 volt scale increments provide greater reading accuracy. Wide frequency range — linearity — true rms reading and Phaostron craftsman construction.

Phaostron Custom Panel Meters, with expanded scale, 90V to 130V AC rms, are available in nine types at your Parts Distributor. For special requirements, write to the Product Development Department for practical recommendations.


2½" or 3½" square meter

6" rectangular meter


2½" or 3½" round meter

PHAOSTRON

PHAOSTRON INSTRUMENT & ELECTRONIC CO., 151 PASADENA AVE., SOUTH PASADENA, CALIF.

terminations and attenuators operating to 4,500 mc. The mismatch is produced in vswr's of 1.25, 1.50, 2.0 and 2.5. The use of evaporated metal resistors and sealed construction make the units suitable for field as well as for laboratory use. A single-page bulletin contains description and prices. **Circle P8 inside back cover.**

TRANSMITTER
for X-band antenna pattern

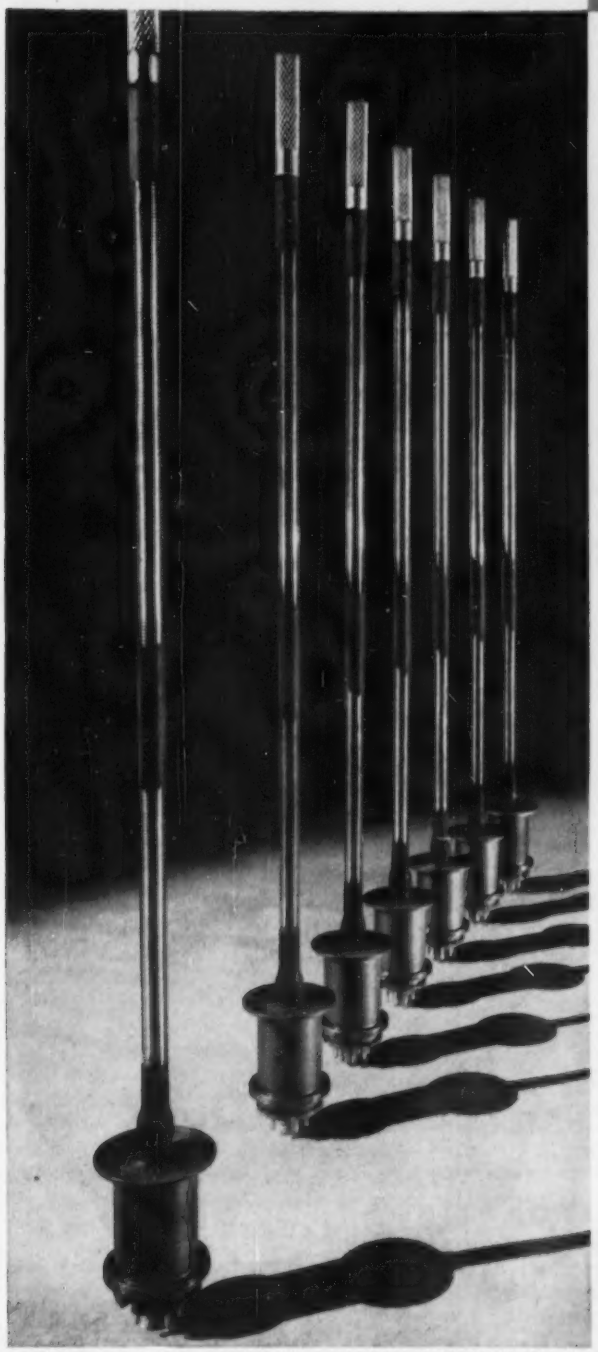
COLOR TELEVISION INC., 935 E. San Carlos Ave., San Carlos, Calif. Providing a convenient r-f source for use on antenna testing ranges, model 119 X-band antenna-pattern transmitter has a self-contained power supply and modulator and is tunable from 8,500 to 9,600 mc. Changes in frequency, polarization, or antenna direction can be made from either the main panel or the remote-control unit, located anywhere on the test range. The latter is available for rack mounting or bench operation (as illustrated).

Designed for outdoor operation, the unit requires minimum open shed protection. The sealed modulator includes a thermostatically controlled heater and the waveguide is provided with a dehydrator to prevent moisture condensation.

▶ **Specifications**—Modulation consists of 1-μsec pulses at a repetition rate of 1,000 per sec. Other specifications include: 24-in. parabola, 33-db gain, 3.5-deg beam width; motor - controlled polarization

New traveling wave tubes for UHF

Sperry marks another "first" with the introduction of these new broadband c-w traveling wave amplifiers—first to cover these important frequency bands. Complete amplifier consists of glass traveling wave tube, matching structure, and focusing magnet (components also available separately).



STP-130 (240-510 mc) STL-132 (500-1010 mc)

HIGH-GAIN (35-50 db), MEDIUM-POWER (3-5 w) AMPLIFIERS FOR TRANSMITTER AND LABORATORY c-w SERVICE

APPLICATIONS

- Laboratory amplifiers
- UHF television
- Communications equipment
- Advanced radars
- Electronic counter-measures
- Satellite transmitters and relays

FEATURES

OPERATING
- Self-aligning in focus magnet
- No positioning adjustments
- Gain curve smooth over band
- Permanent periodic-focus magnets available for airborne use

CONSTRUCTION
- Glass shrunk on helix for rigid support
- Aluminum foil focus magnets
- Light weight

CHARACTERISTICS

	STP-130	STL-132
FREQUENCY RANGE	240-510 mc	500 to 1010 mc
SMALL-SIGNAL GAIN		
MIDBAND-370 mc	45 db (min)	MIDBAND-750 mc, 45 db (min)
MINIMUM	33 db	35 db
GAIN AT 3-WATT OUTPUT POWER	25 db (min)	27 db (min)
SATURATED OUTPUT POWER	3 w (min)	3 w (min)
OPTIMUM SMALL-SIGNAL GAIN BEAM VOLTAGE	625 to 800 v	625 to 800 v
BEAM CURRENT	55 to 75 ma	55 to 75 ma

Write or phone Electronic Tube Division for more facts and figures.

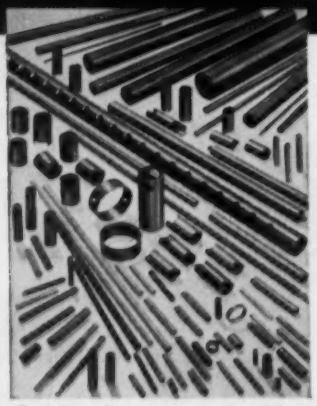
SPERRY **Electronic Tube Division**
GYROSCOPE COMPANY
Great Neck, New York
DIVISION OF SPERRY RAND CORPORATION

CLEVELAND · NEW ORLEANS · BROOKLYN · LOS ANGELES · SAN FRANCISCO · SEATTLE · IN CANADA—SPERRY GYROSCOPE COMPANY OF CANADA, LIMITED, MONTREAL, QUEBEC

CUT DOWN ON THE HIGH COST OF MOISTURE AND CORROSION RESISTANT COIL FORMS...

Specify

RESINITE

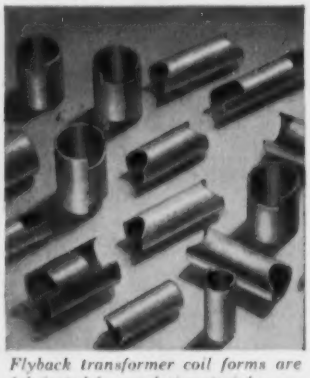


Resinite coil forms are custom-fabricated to specification.

Resinite coil forms are the economical answer to your moisture, heat and corrosion resistant problems. Coil manufacturers have reported that in many applications they are proving equal or superior to previously used and much costlier extruded or molded plastic forms.

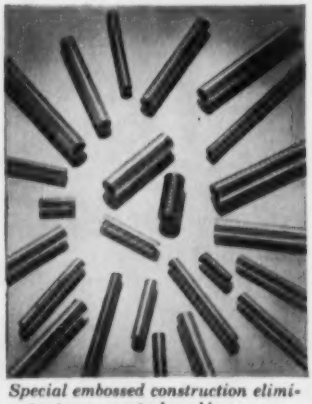
Resinite coil forms provide the highest resistivity of any resinated or phenolic product. They are manufactured by an exclusive process to provide the optimum in both dielectric and mechanical characteristics under the most severe operating conditions. In addition, TruTork internally threaded or embossed forms assure exceedingly high torque control of ±1 inch ounce—axial pressure in excess of 25 pounds.

Various grades of Resinite are available to meet particular requirements. These include: AC for applications where a cellulose acetate covering is desirable; 104 for severe forming, fabricating and stapling; 8104 for minimizing effects of electrical property degradation; and TruTork to provide an internally threaded or embossed form to fit any threaded core—regardless of diameter or threads per inch.



Flyback transformer coil forms are fabricated from select materials.

Get full facts on Resinite coil forms. Write, wire or phone.



Special embossed construction eliminates torque control problems.

Division of **RESINITE CORPORATION**

PRECISION PAPER TUBE COMPANY

2035E W. CHARLESTON ST. • CHICAGO 47, ILLINOIS

Representatives Throughout the United States and Canada

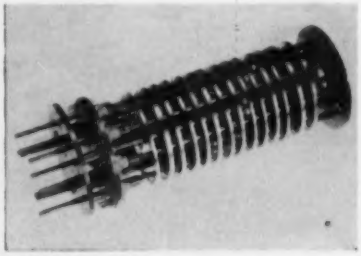
through 360 deg with stops located at 0, 45, 90 and 135 deg; 20-kw peak power; 115-v, 10-ampere, 60-cps input power; price, $12,350. **Circle P9 inside back cover.**

POWER SUPPLY
for 20-kw c-w klystrons

LEVINTHAL ELECTRONIC PRODUCTS, INC., 2760 Fair Oaks Ave., Redwood City, Calif. Developed for powering 20-kw c-w klystrons, the model PC45 power supply provides zero-to-20-kv d-c at currents up to 3 amperes with less than 1 percent ripple and is operated from the remote-control console shown.

The power supply utilizes a motor-driven Powerstat and operates with a power input of 230 v, 3 phase, 60 cps. Meters for measuring beam voltage, beam current, collector current and body current are provided.

The unit is completely protected by door, air, overload, time-delay and external interlocks. A large blower cools the equipment and creates a positive pressure which keeps dust from entering the cabinet. **Circle P10 inside back cover.**



DELAY LINE
for aviation use

DELTINE, INC., 608 Fayette Ave., Mamaroneck, N. Y., has announced a delay line especially developed

WHERE ELECTRONICS MEETS THE EYE

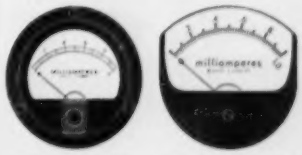
marion
advancement in instrument design

Modern equipment styling directs attention to that critical area, the indicator — where electronics meets the eye of the user. Now, Marion Medalist* meters in your equipment will provide added eye appeal and sales appeal by successfully combining accuracy and reliability with color harmony and distinctive styling.

MARION MEDALIST METERS bring color harmony and functional beauty to panel design. Crystal clear, high temperature Plexiglas** fronts are available in many standard colors with harmonizing or contrasting dials. Custom case and dial colors can also be supplied.

Models include standard 1½, 2½ and 3½ inch sizes, interchangeable with ASA/MIL type mounting, and all standard DC ranges of microamperes, milliamperes, amperes, millivolts, volts, kilovolts, and AC rectifier types including VU and DB meters. The 1½" Medalists are also available as self-contained DC ammeters, rectifier-type AC voltmeters and VU meters.

Marion Medalists have another important advantage — increased readability. In the *same panel space*, a Medalist provides up to 50% *more* scale length — *longer* pointer — *larger* numerals — and *greater* natural dial illumination, than a *standard* round or square meter of the *same size*.



STANDARD METER MARION MEDALIST

These are the reasons that Marion Medalist Meters are setting new standards of appearance and readability, where electronics meets the eye.

*T.M. Reg. U. S. Pat. Off. U. S. & Foreign Patents
**Reg. T.M. Rohn & Haas Co.

marion meters

MARION ELECTRICAL INSTRUMENT COMPANY
GRENIER FIELD, MANCHESTER, NEW HAMPSHIRE

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decade counter

PLUG-IN MOUNT

NEON LIGHT ILLUMINATED DIGIT FROM 0 TO 9. AUTOMATIC RECYCLE BUT DISPLAYS REMAINDER UNTIL RESET.

	MODEL	
Max. (Counting) Rate	140-40	140-100
Resolution	40 Kc/sec	100 Kc/sec
Tubes	8 microseconds	4 microseconds
	4 — 5963	4 — 5963
Dimensions	1½" x 5½" x 5¼"	

northeastern engineering

Manchester New Hampshire

for aviation use and based on the magnetostrictive properties of nickel.

In this delay line a number of spaced impulses are generated from a single pulse and fed into a crystal matrix. By suitably biasing the individual crystals, a pulse code may be obtained. Fifteen pickup coils are precisely positioned by micrometric screws. The resulting pulses have stability of position in time to within 0.05 μsec. The equipment is hermetically sealed. The complete unit weighs less than 1.5 lb. **Circle P11 inside back cover.**

DIGITAL OHMMETER

for precise measurements

NON-LINEAR SYSTEMS INC., Del Mar Airport, Del Mar, Calif. The NLS model 751 is a digital ohmmeter that provides precise automatic measurements of a wide range of resistance values. Designed especially for industrial applications where sturdy construction and the benefits of volume-production economies are of major concern, model 751 has oil-sealed stepping switches for maximum, trouble-free life.

Resistance values are displayed by 4 in-line luminous numerals 1 in. high, with automatically-shifting decimal point and automatically-varied resistance symbols. Permanent records can be made by connection of accessory NLS digital recording systems.

▶ **Technical Data**—Range of the instrument is from 0 to 9.999 megohms with minimum resolution of 10 ohms. Sampling rate is 60 cps; response, 1 second (aver-

CORES

Name it . . . if it's a Ferrite, a Magnetic Iron Core, a Molded Coil Form (Iron and phenolic) or an E. E. Core, MOLDITE makes it and MOLDITE is your one consistently dependable source.

MOLDITE continues to pioneer with new methods and techniques closely related to automation in manufacturing stud and studless powdered iron cores. This will enable MOLDITE to produce faster, better and cheaper.

In addition, color TV is finding MOLDITE in the forefront with highly specialized equipment built and designed by MOLDITE engineers for both quality and quantity production.

Truly MOLDITE means Cores Unlimited for unlimited electronic applications today . . . tomorrow!

Send for our Catalog 120

NATIONAL MOLDITE COMPANY

1410 CHESTNUT AVE., HILLSIDE 3, N. J.

IRON CORES • FERRITES • MOLDED COIL FORMS • E E CORES

Robert T. Murray Co. 604 Central Avenue East Orange, N. J.	William A. Franklin 3 Holly Road North Syracuse, N. Y.	Jerry Golten Co. 2750 W. North Ave. Chicago 22, Ill.	Engineering Services Co. 4550 Main St. Kansas City, Mo.	Perimuth Electronics Assoc. 2419 South Grand Ave. Los Angeles, Cal.	John S. Plewes Co. 52 Humbercrest Blvd. Toronto 9, Ontario	Jose Luis Ponte Cardoba 1472 Buenos Aires

Want more information? Use post card on last page.

Kearfott

FERRITE

MICROWAVE COMPONENTS

KEARFOTT
FERRITE DUPLEXERS

Improvements in recovery time, reduction in insertion loss and excellent magnetron isolation are performance benefits offered by Kearfott Ferrite Duplexers – designed to meet specific radar space requirements.

A Faraday rotation type unit is illustrated. A type and configuration is available for your requirements.

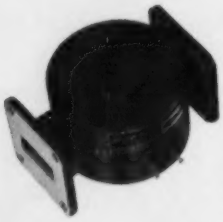
KEARFOTT
FERRITE ISOLATORS

For superior performance KEARFOTT ISOLATORS *custom* designed to fit the exact combination of characteristics, available space and configuration for *your* radar system. For high or low power – for broad or narrow band use and with db ratios of isolation to insertion up to 150 to 1.

Kearfott offers 3 types of Ferrite Isolators to assure the optimum performance of all microwave applications.

KEARFOTT
FERRITE ATTENUATORS AND SWITCHES

Ferrites offer new circuit possibilities and product improvement for AGC and electronic switching of R.F. energy. Kearfott designs, precisely tailored to your most exacting requirements, assure maximum performance and reliability with minimum weight.



The 30 db variable attenuator illustrated, requires less than 3 watts control power.

Write for Bulletin W-103 which gives full details of these Ferrite Microwave components.

Kearfott's complete Microwave engineering and fabrication facilities are at your command. Inquiries on your Microwave problems will be treated in confidence.

Kearfott COMPANY, INC.
LITTLE FALLS, NEW JERSEY
WESTERN DIVISION
253 VINEDO AVE., PASADENA, CALIF.
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Chicago, Ill.

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6115 Denton Drive
Dallas, Texas

age); and accuracy is ±0.1 percent of measured resistance or one digit, whichever is greater. Weighing 40 lb, the digital ohmmeter is available in rack mount and portable styles. **Circle P12 inside back cover.**

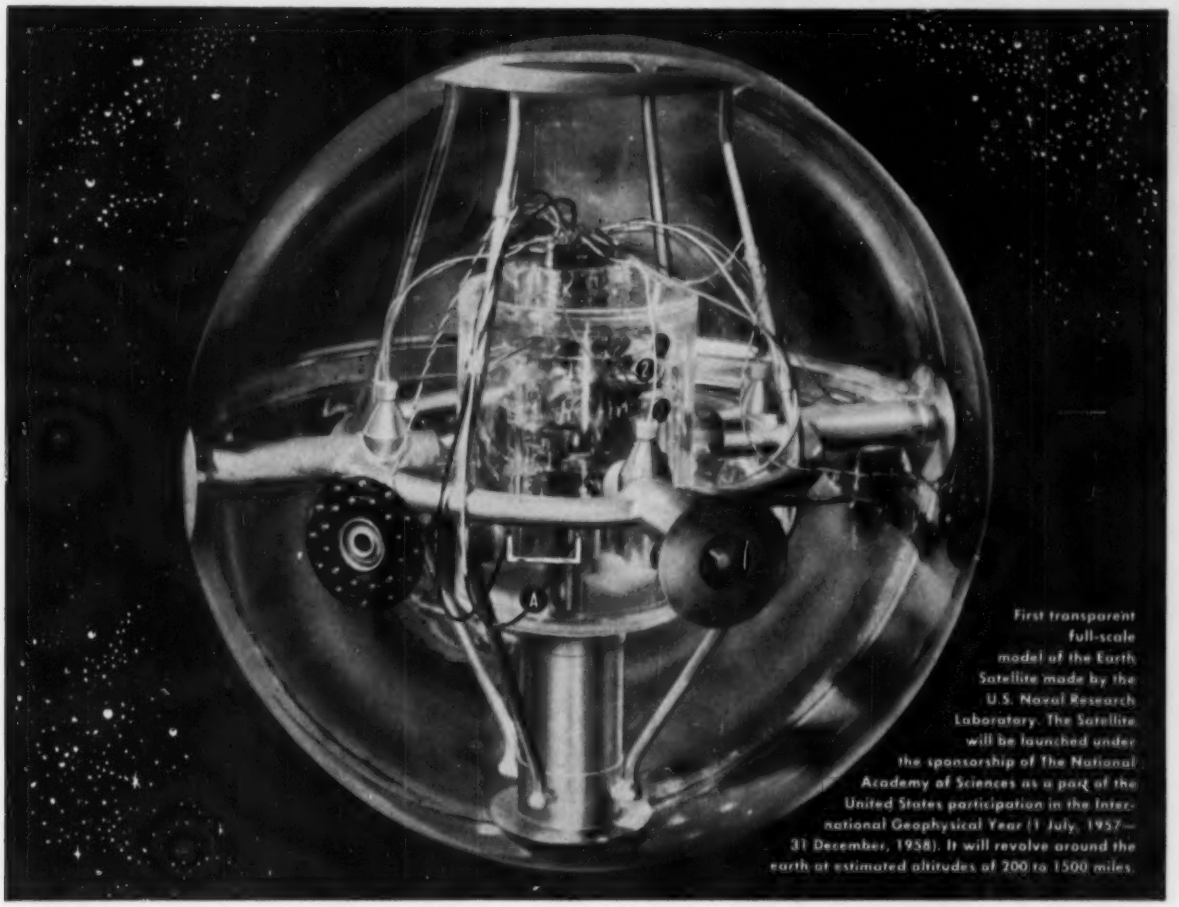
FLUX KIT
for specific soldering jobs

ALPHA METALS, INC., 56 Water St., Jersey City, N. J., has announced its newly revised general purpose flux kit, which contains 16 of the most recently advanced fluxes for electronic assemblies, printed circuits, tinning and hot solder dipping, stainless steel soldering and aluminum soldering. The kit will now enable engineers, designers and production men to quickly determine the proper flux for specific soldering jobs.

Cost of the kit is $7.50. **Circle P13 inside back cover.**

MAGNET CHARGER
costs less than $2,000

RADIO FREQUENCY LABORATORIES, INC., Powerville Road, Boonton, N. J. Model 942 magnet charger is capable of charging large Alnico magnets, ceramic magnets, and



First transparent full-scale model of the Earth Satellite made by the U.S. Naval Research Laboratory. The Satellite will be launched under the sponsorship of The National Academy of Sciences as a part of the United States participation in the International Geophysical Year (1 July, 1957—31 December, 1958). It will revolve around the earth at estimated altitudes of 200 to 1500 miles.

How measure the impact of micro-meteorites on the first "Earth Satellite"?

When physicists at the U.S. Naval Research Laboratory consider an instrument or a material to record accurately the secrets of outer space—it's not size alone that counts, but dependable, reliable precision.

The strip of "Nichrome"* evaporated on glass ("A" in the photo above) which may be fitted to the outer skin of the Satellite, measures only ¼" wide x 1½" long. Its thickness: 100 Angstrom units (1/10,000 mm). Its function: to measure the surface erosion caused by the impact of micro-meteorites. The resistance of the Nichrome ribbon increases as the film becomes pitted by meteor particles.

"Nichrome is being considered for making this gage," states the Naval Research Laboratory, "because it supplies electrical resistance in a desirable range; adheres satisfactorily to glass in thin film form; and has a very low thermal coefficient of resistance."

There'll be no one on hand, 300 miles out in space, to check on or supervise the performance of the Nichrome strip. Nichrome needs no one. It will do its job dependably there—just as it will in *your* electronic or electrical equipment, after it is in your customers' hands.

And remember, Nichrome is only one of the 132 special purpose alloys developed by Driver-Harris since 1899 for electrical heating, resistance, and electronic applications. Do you need a special alloy? Send us your specifications.

*T. M. Reg. U. S. Pat. Off.

Driver-Harris COMPANY HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Louisville, Los Angeles, San Francisco In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario

MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD

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DIRECT READING

new
Computer-Measurements Model 226A

UNIVERSAL COUNTER-TIMER

FREQUENCY • PERIOD • TIME INTERVAL • FREQUENCY • PERIOD • TIME INTERVAL • FREQUENCY • PERIOD • TIME INTERVAL • FREQUENCY • PERIOD • TIME INTERVAL • FREQUENCY

OUTSTANDING FEATURES:

★ Three independent, adjustable trigger level controls permitting full rated sensitivity at any voltage level between 300 and 300 volts.

★ Small voltage increments ordinarily masked by attenuators are easily selected.

★ Simplified color-coded controls and direct read-out in kc, mc, sec, or millisec, with automatic decimal point indication.

★ Oscilloscope marker signals facilitate start and stop trigger level adjustment for time interval measurement of complex waveforms.

A brand new, multi-purpose instrument provides precision measurement of frequency, frequency ratio, period (1/frequency) and time interval. Pressure, velocity, acceleration displacement, flow, RPS, RPM, etc., may also be measured with suitable transducers. The 226A may be used as a secondary frequency standard.

price: $1,100.00

SPECIFICATIONS:

FREQUENCY MEASUREMENT

Frequency Range: 0-1,000,000 cycles per second
Input Sensitivity: 0.2 volt rms. Direct-coupled input
Time Bases: 0.00001, 0.0001, 0.001, 0.01, 0.1, 1 and 10 seconds. Also can use external 0-1 mc standard

PERIOD MEASUREMENT

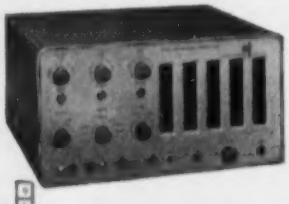
Period Range: 10 microseconds to 1,000,000 seconds
Frequency Range: 0.000001 cps to 100 kc
Input Sensitivity: 0.2 volts rms. Direct-coupled input
Gate Times: 1 and 10 cycles of unknown frequency
Standard Frequency Counted: 1 mc; 100, 10, 1 kc; 100, 10, 1 cps; external 0-1 mc.

TIME INTERVAL MEASUREMENT

Range: 3 microseconds to 1,000,000 seconds
Start and Stop: Two independent or common channels Positive or negative slope
Input Sensitivity: 0.2 volts rms. Direct-coupled input
Standard Frequency Counted: 1 mc; 100, 10, 1 kc; 100, 10, 1 cps; external 0-1 mc.

GENERAL

Stability: Short Term: 1 part in 1,000,000 (temperature-regulated crystal)
Long Term: 3 parts per million per week
Display Time: Automatic: Continuously variable 0.1 to 10 seconds Manual: Until reset
Input Impedance: 1 megohm and 50 mmf
Trigger Level: Continuously adjustable from −300 to +300 volts
Accuracy: ± 1 count ± stability
Secondary Frequency Standard: 1 mc; 100, 10, 1 kc; 100, 10, and 1 cps
Dimensions: 17" W x 8¾" H x 13½" D approx.
Weight: 50 lbs. approx.



MODEL 225A 0 cps-100 kc
UNIVERSAL COUNTER-TIMER
Similar to the 226A in design. Featuring Oscilloscope Trigger Level Marker Signals; **Three Direct-Coupled Inputs of 70 mv sensitivity;** Direct Reading, Automatic Illuminated Decimal Point. Easily portable. **Price: $840.00**

Data Subject to Change Without Notice — Prices F.O.B. Factory

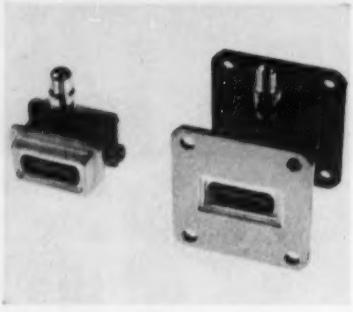
Write for complete specifications on the new 226A and the 225A models and the complete CMC line of electronic counting and controlling equipment.

Computer-Measurements Corporation
5528 Vineland Avenue, North Hollywood, Calif. Dept. 78N

CC-36

other materials requiring large peak magnetizing forces. With its accessories, it is designed to charge permanent magnets requiring up to 200,000 ampere-turns peak magnetizing force for saturation.

This charger is essentially a 3,000-v power supply with control and interlock circuitry and storage capacitors from 200 to 800 μf. The energy stored in the capacitor bank is discharged by means of an ignitron in a single unidirectional pulse into a pulse transformer and magnetizing adapter. The resulting high flux density charges the magnet. The ampere-turn rating depends upon the size and type of pulse transformer purchased to operate with the model 942. Two standard pulse transformers, a 30 cu-in. wire-wound fixture, and many adapters and inserts are available to charge rod, bar, ring, U, multipole rotor, and special permanent magnets. **Circle P14 inside back cover.**

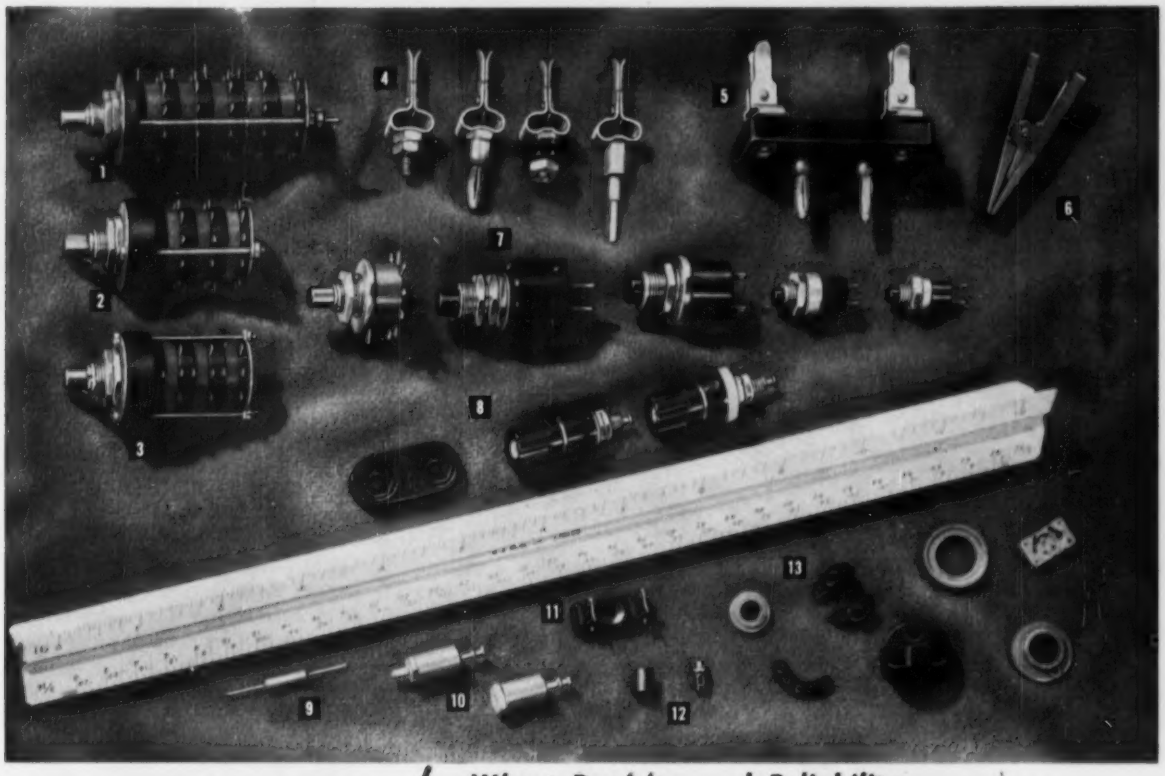


MINIATURE T-R TUBE
meets high shock, vibration

SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y., has announced a new t-r tube for application in radar systems. The tubes serve as electronic switches permitting the equipment alternately to send and receive signals with one antenna.

The Bantam t-r, type 6795, was developed to meet requirements in commercial radar for a tube combining small size, ease of installation and removal, and low cost.

A broad-band tube operating in the 8,500-9,600 mc frequency range, the new device equals all electrical characteristics of the 1B63A, a tube nearly twice its



GRAYHILL / *Where Precision and Reliability are built into "small packages"*

The Grayhill engineers were among the first to recognize the trend toward miniaturization and to build into these smaller electronic components the precision and quality required for dependable, accurate performance. The widespread and rapidly growing acceptance of Grayhill components by many leaders in the electronic industry is ample evidence of their inherent quality and reliability, and their compatability to modern electronic design.

Whenever you need any of the following components, you can specify Grayhill with complete confidence!

1 **GRAYHILL SERIES 5000 ROTARY TAP SWITCH**—A quality built tap switch designed to conserve panel space. Rated at 1 amp. 115 Volts AC, resistive — will carry 5 amps. as a selector switch only. Non-shorting (break before make) or shorting (make before break) 2-10 positions per deck, 1 to 10 decks.

GRAYHILL SERIES 12 ROTARY TAP SWITCH—Same as Series 5000 in appearance, dimensions and electrical characteristics but suitable for military applications, and where subject to severe environmental conditions such as salt spray, humidity, etc.

2 **GRAYHILL SERIES 24 ROTARY TAP SWITCH**—Similar to Series 5000 except for POSITIVE DETENT ACTION and better "feel" for precision requirements.

3 **GRAYHILL SPRING RETURN ROTARY SWITCH**—Similar to Series 24 except this switch gives momentary contact on either side of center position only. 1 to 3 decks, shorting or non-shorting.

4 **GRAYHILL TEST CLIPS**—For fast testing when mounted on test panel board. Leads slip easily in and out of clamp-type jaws. Adjustable spring action. Useful in laying out harness on perforated board. Available with threaded stud for laminated panels, threaded stud with insulated clip for metal panels, banana plug, and pin plug.

5 **GRAYHILL PLUG-IN ADAPTORS**—Designed for testing resistors, capacitors, and similar pig-tail type components on standard test equipment. Banana plugs on ¾" spacing. Molded phenolic base.

6 **GRAYHILL INSULATED TEST CLIPS**—Fully insulated to permit two or more to be laid side by side without shorting. Molded phenolic finger grips. Insulated hinge pin.

7 **GRAYHILL PUSH BUTTON SWITCHES**
Series 2000—SNAP ACTION SWITCH—Momentary contact SPST. Rated 10 ohms, 115 Volts, AC, resistive. A distinct click at moment of actuation make it desirable for test equipment. Either normally open or closed.
Series 4000—SILENT ACTION SWITCH—Momentary contact, SPST non-snap switch. Rated ½ amp. 115 Volts AC, resistive.
Series 23-1—MINIATURE SILENT ACTION—A Non-Snap, momentary contact SPST switch, rated ¼ amp., 115 Volts, resistive. Mounting bushing 5/16"—32 thread. Overall length 1¾". Max. dia. ½".
Series 30-1—MIDGET SILENT ACTION SWITCH—A sub-miniature, non-snap, momentary contact SPST push button switch. Rated .10 amp. 115 Volts AC, resistive. Mounting bushing ¼"—32 thread, overall length 45/64", max. dia. 3/8".

8 **GRAYHILL BINDING POSTS**
Series 29—½" diameter, permits mounting on ¾" centers in ⅜" mounting hole. Non-turn "D" washers. Flush crosshole. Also available for ½" mounting hole. Molded phenolic, base available for dual mounting.

9 **GRAYHILL COIL FORMS**—Molded of mica-filled phenolic (MIL-P-14, Type MFE) for low loss at high frequencies, low moisture absorption, high dielectric strength and fungi resistance. Tinned copper wire leads. Available in diameters from ⅛" to ¼", body length ½" to 1".

10 **GRAYHILL STAND-OFF INSULATORS**—Bodies are molded of mica-filled phenolic (MIL-P-14, Type MFE) for low high frequency loss, high dielectric strength, low moisture absorption and fungi-resistance. Silver plated, brass solder terminals. Front of panel length 13/16". Diameter 5/16".

11 **GRAYHILL DIODE HOLDER**—Provides tight snap fit with spring tension clip. Loop terminal and spring clip formed of one piece of phosphor bronze wire, gold plated, for easy soldering and corrosion resistance. Molded phenolic base. Length 15/16", width 3/8", height 3/8", center to center of clips .635".

12 **GRAYHILL TEST JACKS**—
Series 31—Designed for printed circuits as a test point to feed AF, RF and Pulse signals, check and feed DC voltages, monitor signals during test, alignment, etc. For standard .081" to .0825" tip phone plugs. Rivets to board like an eyelet. For 1/16", 5/32" and ⅛" board. Snap-on plastic sleeves available.

13 **GRAYHILL MOLDED PARTS**—Through its own patented automatic transfer molding machines, Grayhill can greatly reduce the cost of your thermo-setting plastic components in quantities from 50 to 200,000 and provide increased design flexibility. Maximum sizes 1⅛" x 1⅛" by 3/8".

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523 Hillgrove Avenue • La Grange, Illinois

• Threshold voltage adjustment
• Fixed gain adjustments

THERE'S A TIC TRIMMER POT for every application

• Critical magnetic and electric bias
• Balancing adjustments
• Padding
• Adjusting scale factors
• Parameter compensation
• Fixed reference circuits

TIC manufactures in production quantities the most complete line of precision trimmer potentiometers in the industry. Common to all TIC trimmers is the unexcelled TIC quality construction and advanced design. The wide selection of sizes and shapes, in addition to the wide range of power and temperature capabilities, permit selection of units of maximum compatibility with a specific application.

The TIC Trimmer Potentiometer Line includes units from ⅛ inch to 1 inch in size . . . 50 to 100K ohms in resistance . . . . −55° C to +145° C temperature range . . . power ratings up to 4 watts. Advanced mechanical design provides extremely precise, stable adjustments under all forms of adverse environmental conditions.

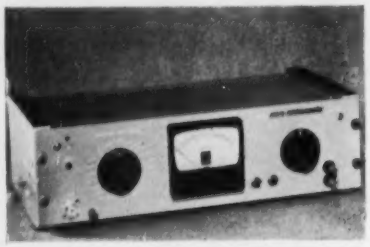
TIC was the originator of the high stability subminiature trimmer pots. For example the original metal-film potentiometer, the TIC RFT Metlfilm, represents the outstanding advance high stability trimmer potentiometer design. The RFT contains a resistance element of metallic film that provides infinite resolution for ultra-fine trimming. Compactness of the RFT permits stacking 7 to the square inch. Latest addition to the TIC Trimmer Line is the new low cost RWT which, like the RFT, provides adjustment by use of a 25-turn lead screw.

Complete information on the TIC Trimmer Potentiometer Line is available upon request.

TECHNOLOGY INSTRUMENT CORP.

569 Main Street, Acton, Mass., COlonial 3-7711.
West Coast Mail Address, Box 3941, No. Hollywood, Calif., POplar 5-8620

size used in the same applications. **Circle P15 inside back cover.**



MICROMICROAMMETER
features high stability

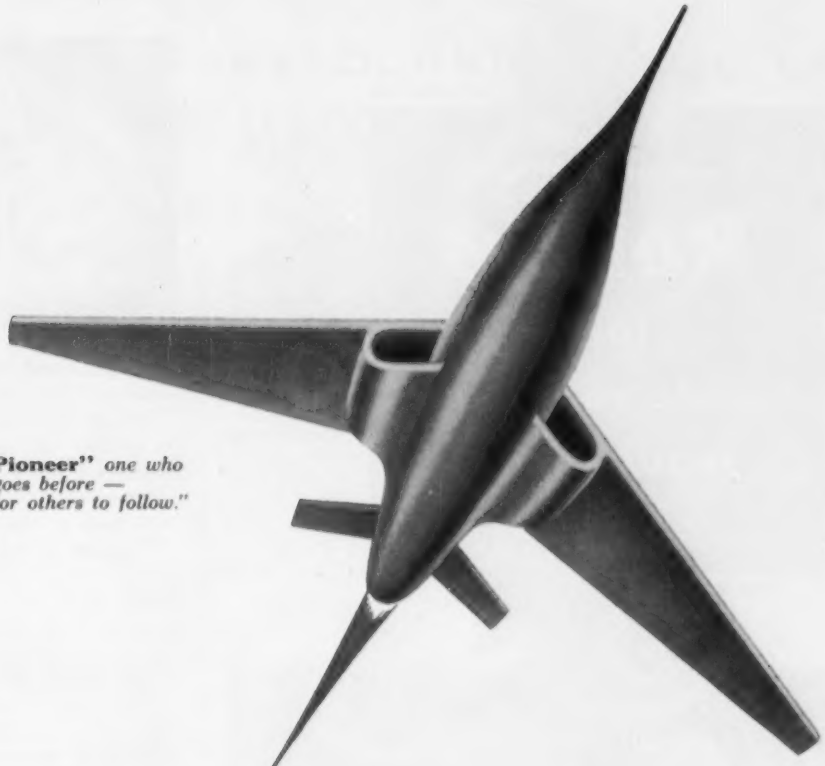
KEITHLEY INSTRUMENTS, INC., 12415 Euclid Ave., Cleveland 6, Ohio. Model 410 micromicroammeter measures low currents in photocells, v-t grids, semiconductors and ion chambers. Other applications include such diverse functions as area monitoring and liquid level control, when used with the proper transducers.

The 410 differs from commercial vacuum tube and vibrating reed electrometers primarily in its combination of stability, convenience and economy. It measures currents over 10 decades on 20 ranges, from 1 by 10^{-3} to 3 by 10^{-13} ampere full scale. Accuracy is within ±3 percent or better. Zero drift is less than 2 percent of full scale after a 5-minute warmup, with less than 2 percent in any subsequent 24-hr period.

Other features include the ability to drive 1-ma or 5-ma recorders as well as the 50-mv rebalancing types; a regulated tap of about 250 v for polarizing ion chambers; and input noise below 1 percent full scale on all ranges. **Circle P16 inside back cover.**

PRECISION POT
spring loaded, linear motion

G. M. GIANNINI & CO., INC., 918 E. Green St., Pasadena 1, Calif., has announced the 86125A Pancake Rectipot, a miniature spring loaded linear motion precision potentiometer. Designed for applications requiring measurement of a short stroke in limited space, it has less than 1 in. of body length

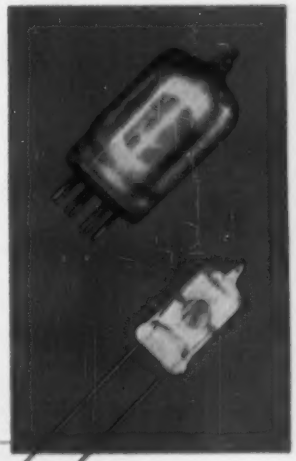


"Pioneer" *one who goes before — for others to follow."*

IF WEBSTER IS RIGHT —
Then Midland Has Done It Again, this time with

glass holders for crystals!

Permanent high vacuum attainable *only* with glass, isolates the crystal from atmospheric factors detrimental to dependable performance. Truly, here are crystals designed with the future in mind — future requirements of application and design as well as the long life of the unit far into the future.



Midland MANUFACTURING COMPANY, INC.

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World's Largest Producer of Quartz Crystals

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for a
wide range of
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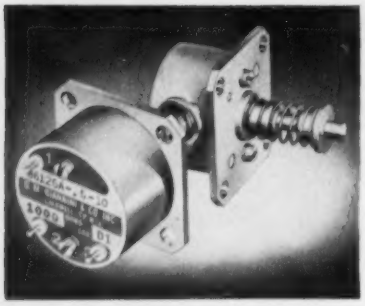
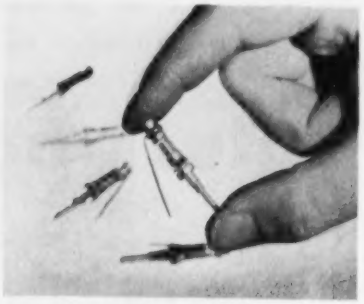
Whatever your relay needs may be, it will pay you to contact Comar. Electrical characteristics, sizes and mountings are tailor-made to exactly fit your requirements. Precision-engineered, easier to install, more efficient in operation. Send specifications for our recommendations and prices.
PLUG-IN
SMALL SPACE
HERMETIC SEALING



for a full half inch stroke of the stainless steel shaft.

Standard stroke ranges from 0.1 in. to 0.5 in. are offered in resistance ranges of 1,000 and 2,000 ohms with linearity of ±1 percent and resolution of 0.0012 in.

Capable of long life under adverse conditions of vibration, acceleration and temperature, the 86125A is designed for use in laboratory equipment, fire control systems, remote flight controls, servo follow-up on linear actuators, and industrial control systems. **Circle P17 inside back cover.**



GLASS TRIMMER
with linear tuning curve

CORNING GLASS WORKS, Corning, N. Y., has introduced a new precision glass trimmer capacitor with a linear tuning curve. Measuring only ¾ in. deep behind the chassis, the new capacitor, Code 682014, is ideal for critically tuned r-f circuits and high Q tuned circuits.

▶**Specifications**—Minimum Q is 500 at 50 mc. Temperature coefficient of capacitance is +50 ±50 ppm per deg C. Adjustment tongue is 0.029 in. wide; the mounting has a standard bushing 8-32 thread. Constructed of glass tubing with a coating of metal

let DeMornay-Bonardi build your COMPLETE MICROWAVE SYSTEMS

-you'll save design time and testing time.

Cost is 25% to 50% less. Delivery months sooner!

Using "building-block" methods, D-B saves you time and money in special purpose system construction. We manufacture and stock 924 types of reliable components, from 2.60-90.0 KMc/SEC. This wide choice gives us the flexibility to build for any application, and allows better control over the elements in a complex system. It greatly simplifies design, saving weeks of trial-and-error methods.

Each D-B component selected from stock is already tested—hence the assembly needs no proving... checks out as soon as it's put together... is guaranteed to work. With so many savings in engineering time, D-B can complete a system at a price 25% to 50% lower than your costs. Delivery time is cut by months.

All we need from you to construct a special purpose waveguide system are your electrical requirements and space allowance. We do the rest with building blocks, proved in use since 1941. Talk it over with a D-B representative, or write direct. New D-B catalog now ready—request a copy on your company letterhead.

Heterodyne System Designed for Beckman Instruments, Inc.

This system was designed to measure an unknown frequency anywhere between 10 KMc and 50 KMc by heterodyning it against a set of precisely known frequencies which are generated by multiplication from a low frequency primary standard. The system provides:

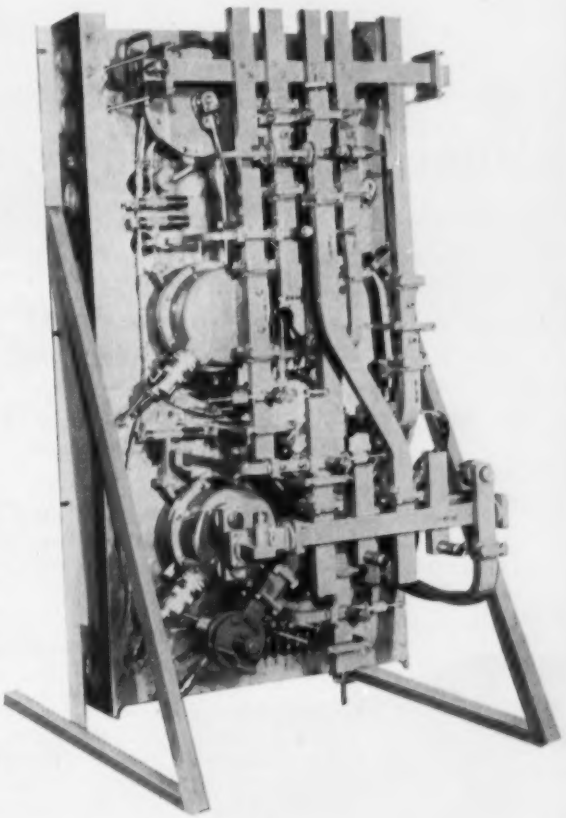
a. Generation of standard reference frequencies by means of Klystron multiplier, a balanced sideband generator, crystal multipliers and band-pass filters.

b. Coarse measurement and filtering of the unknown frequency by means of cavity wavemeters.

c. Selection of the proper channel by means of three SPDT switches plus a special 3-way and 5-way switch for transitions from one waveguide size to another.

d. Mixing of the unknown frequency with the properly selected reference frequency to provide an unambiguous beat frequency.

Except for the 3- and 5-way switches, all waveguide components used in this system are either stock D-B catalog items, or minor modifications of them—an important factor in quick delivery.



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FAST PULSE GENERATOR

- Output Flexibility
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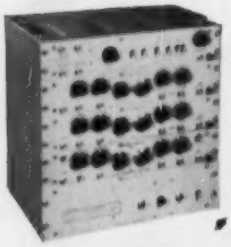
ECONOMICAL... *...FAST RISE TIME*

Model 2125A

A wide range instrument designed for the economical generation of fast rise time pulses at low impedance. Direct coupled output at ground potential minimizes waveform problems, and optional use of internal load allows provision of full power to low impedance loads and optimum waveform to higher loads.

• 90 V Amplitude Open Circuit, 50 V into 50 Ohm Load • .02 μs Rise Time • 10 CPS to 100 KC Rep. Rate • 0 to 100 μs Delay or Advance • .1 to 100 μs Pulse Width • 60 DB Attenuator.

Write for Complete Data: Our Bulletin 2125A/E



The Model 2125A Pulse Generator is the latest addition to the Electro-Pulse line of electronic instrumentation which includes Precision, Variable, and Megacycle Pulse Generators, Pulse Code Generators, Pulse Oscillators, Time Delay Generators, and Electronic Counting Equipment.

Model 2120A PRECISION PULSE GENERATOR

Representatives in Major Cities

Electro-Pulse, Inc.

11861 TEALE STREET, CULVER CITY, CALIFORNIA
Telephones: EXmont 8-6764 and TExas 0-8006

bonded to it, the trimmer capacitor has a silver-plated Invar core and wire terminal. Hardware is included with the unit. **Circle P18 inside back cover.**

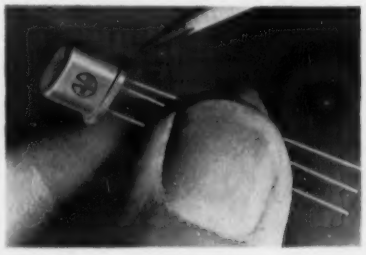
TRANSISTOR METER

portable, battery operated

DURSON Co., 10416 National Blvd., Los Angeles 34, Calif. Transistometer No. 101 tests both *pnp* and *npn* low power junction transistors. It permits small signal beta measurements to 250 using two scales, 0-50 and 0-250. Both I_{co} and beta measurements are directly comparable with transistor manufacturers' specifications.

All functions are controlled by a single switch with sequence arranged to afford meter protection. The meter is also protected against excessive overloads. Internal transistors are interchangeable with similar types without circuit alterations or factory calibration.

The unit is ideal for laboratory or production line testing. Weight is less than 6 lb. It is available in kit form at $67.50. **Circle P19 inside back cover.**



AUDIO TRANSISTOR

pnp germanium unit

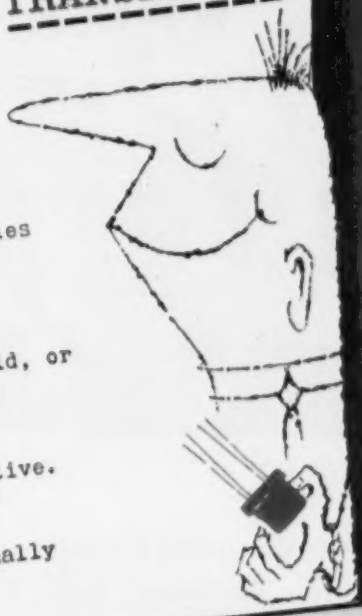
MARVELCO ELECTRONIC DIVISION OF NATIONAL AIRCRAFT CORP., 3411

MEMO

FROM: The Engineering Staff at N J E

TO: Electronic Design Engineers

SUBJECT: A Few Calm Words About **TRANSISTORS**



Those of us who have been around this wild and wooly world of electronics for a decade or two are naturally conservative about each new "miracle" that comes along. The latest is the transistor.

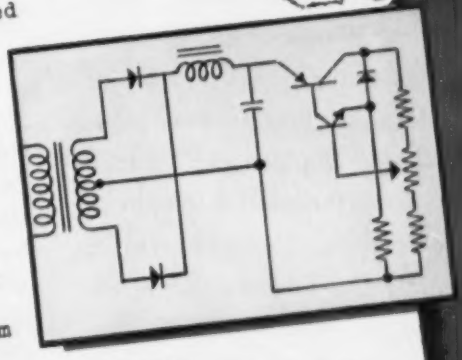
Here at NJE, we have worked long and hard—and successfully—to transistorize power supplies appropriately. We are impressed with our early results...but we are not ready to junk every other technique we know.

A few calm words are in order—

*The transistor will not cure the common cold, or any other common ailment—such as marginal design, line surges, or pulse loads.

*Above about a kilowatt, the expense of a pure-transistor technique becomes prohibitive. A combination of mag-amps and transistors looks best at higher levels.

*Although the basic circuitry is exceptionally simple (see typical diagram, below), parameters must be carefully restricted to avoid component selection and serious instability.



On the positive side, however:

*Transistors offer very precise regulation, low ripple, and zero-lag transient behavior at voltages below 50 volts at high efficiency.

*Size, weight, and heat reductions are often startling.

*Reliability and resistance to shock and vibration is generally greatly improved by replacing vacuum tubes with transistors.

Don't get us wrong, now—we love progress. We love transistors, too. If you think transistorization will solve your power supply problems, we want to show you what we can do... but all we offer is solid, conservative engineering...no miracles.

NJE corporation

Electronic Development & Manufacturing

345 CARNEGIE AVENUE, KENILWORTH, N. J.

"POWER SUPPLY ENGINEERS: In a rut? Want to work at the forefront of the electronic power supply field? Our expansion is limited only by the size of our hand-picked engineering staff. Excellent compensation, recognition, security. Stimulating colleagues and challenging jobs. Write to T. C. Gans, Director of Research, for telephone or personal interview. Will consider capable Circuit Engineers with only nominal power supply background for rapid training and development in this essential and challenging field."

POWER SUPPLIES UNLIMITED

insulated
TERMINAL LUGS

miniature *and* **standard**

USECO offers quality insulated lugs with... Immediate deliveries · Wide selection of types · Phenolic or moulded melamine · High dielectric strength—Choice of platings · Swaged types or threaded, internally or externally · Packed in strong, protective bags for protection and convenience · Quick service from 135 jobbers and 31 representatives. Write today for name of nearest jobber and representative. Please address Department 16.

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U. S. ENGINEERING CO., INC.
A Division of Litton Industries, Inc.
5873 RODEO ROAD • LOS ANGELES 16, CALIFORNIA

Tulare Ave., Burbank, Calif. A new low noise audio transistor for use at audio and ultrasonic frequencies is now available. It is a *pnp* germanium diffused alloy junction unit hermetically sealed in a resistance welded metal case with glass-to-metal seals to secure the 1½ in. leads. The unit is designed for high gain (B = 70), low-to-medium power applications (150 mw).

▶ **Maximum Ratings**—Collector dissipation is 150 mw; collector voltage, −45 v; collector current, −20 ma; ambient operating temperature, 55 C; and ambient storage temperature, 85 C.

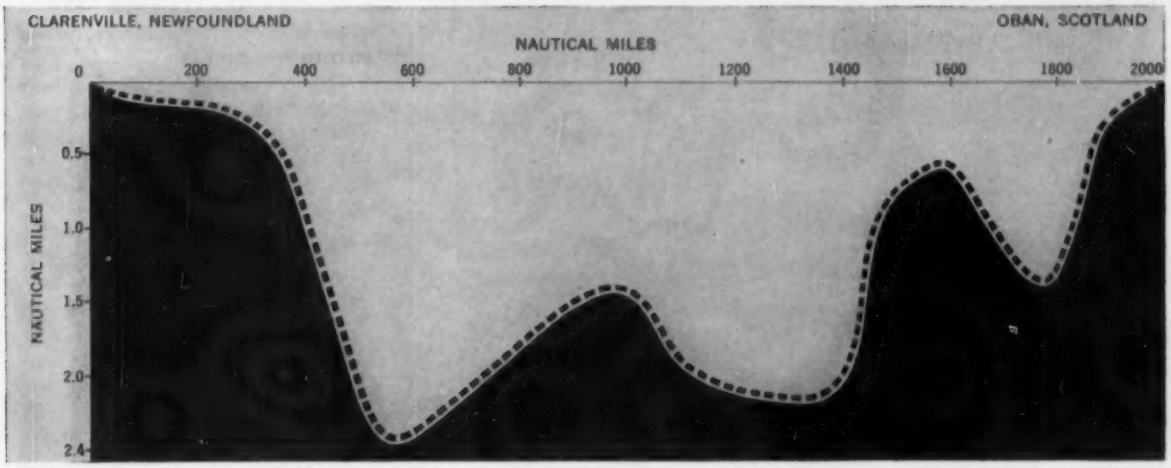
Typical characteristics measured at 1 kc and 25 C are as follows: collector voltage, −6 v; emitter current, 1 ma. **Circle P20 inside back cover.**

PICTURE TUBES
for portable tv sets

WESTINGHOUSE ELECTRIC CORP., Electronic Tube Div., Box 284, Elmira, N. Y., has added to its line of Reliatron tubes two new picture tubes, types 14NP4 and 14NP4A, for portable tv sets. Both are directly viewed and of rectangular glass construction. A new bulb design permits 90 deg deflection. This design increases picture area and decreases tube length by 2 in. Overall length of each tube is 14¼ in.

The sperical faceplates are made of neutral gray glass, minimizing reflections and improving picture

A TRIUMPH OF TELEPHONE TECHNOLOGY



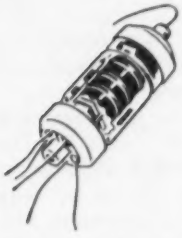
Contour of ocean bed where cable swiftly and clearly carries 36 conversations simultaneously. This is deep-sea part of system – a joint enterprise of the American Telephone and Telegraph Company, British Post Office and Canadian Overseas Telecommunications Corporation.

A great new telephone cable now links North America and Europe—the first transoceanic cable to carry voices.

To make possible this historic forward step in world communications, Bell Laboratories scientists and engineers had to solve formidable new problems never encountered with previous cables, which carry only telegraph signals.

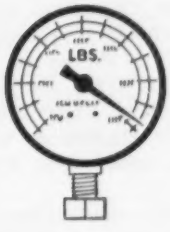
To transmit voices clearly demanded a much wider frequency band and efficient ways of overcoming huge attenuation losses over its more than 2000-mile span. The complex electronic apparatus must withstand the tremendous pressures and stresses encountered on the ocean floor, far beyond adjustment or servicing for years to come.

Here are a few of the key developments that made this unique achievement possible:

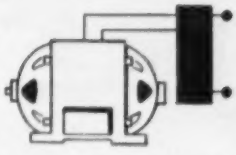


More than 300 electron tubes of unrivaled endurance operate continuously, energized by current sent from land.

Precisely designed equalizing networks and amplifiers compensate for the loss in the cable every 40 miles and produce a communication highway 144 kc. wide.



A unique triple watertight seal protects the amplifiers from pressures as high as 6500 pounds per square inch.

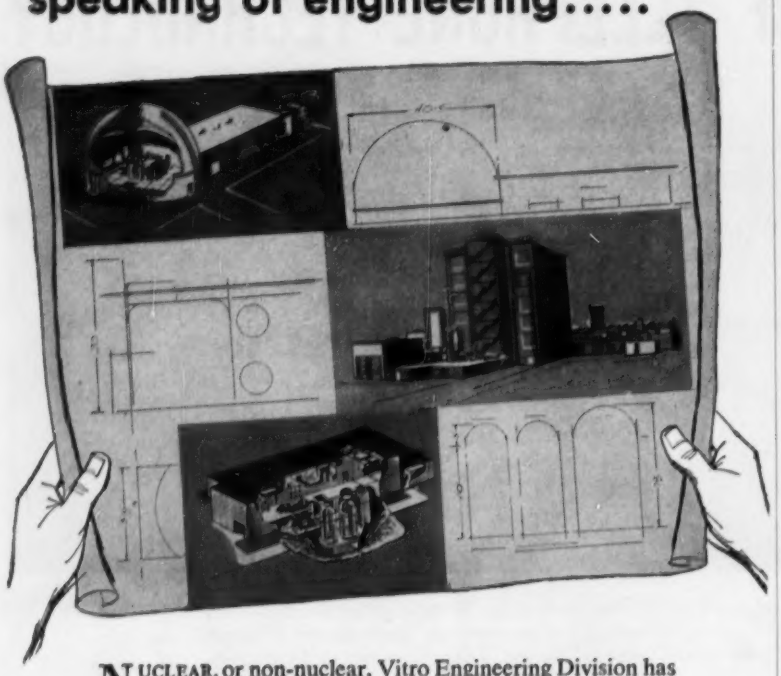


Power supplies of exceptional reliability send precisely regulated current along the same coaxial that carries your voice to energize the amplifying units.

BELL TELEPHONE LABORATORIES

World center of communications research and development

speaking of engineering.....



NUCLEAR, or non-nuclear, Vitro Engineering Division has created outstanding records in the engineering, design and construction of the newest and best in technical facilities for industry and government.

IN THE NUCLEAR FIELD

Vitro is across the map in atomic energy. Whether scoping a heavy water plant in India, working on Consolidated Edison's full-scale power reactor or designing atomic facilities for Lockheed's nuclear-aircraft project, you'll find Vitro engineers at work.

Vitro, in nuclear engineering since 1942, has designed and built facilities for uranium isotope separation (Oak Ridge), plutonium production (Hanford), uranium milling and refining (Salt Lake City and Canonsburg), hot laboratories, and processing plants.

IN OTHER FIELDS

Vitro has designed and built nerve gas installations for the Army, armament test facilities for the Air Force, and for private industry the country's largest titanium production plant, processing plants, including a sugar refinery, acrylonitrile plant, and ore and mineral production works.

Wherever plans are afloat for difficult engineering projects, it's a good bet Vitro engineers are there. May we discuss your engineering problems?

Write for detailed information to **VITRO ENGINEERING DIVISION**

Vitro **CORPORATION of AMERICA**
261 Madison Ave., New York 16, N.Y.

DIVISIONAL ACTIVITIES

- Research, development, weapons systems
- Nuclear and process engineering, design
- Refinery engineering, design, construction
- Uranium mining, milling, processing, refining
- Rare metals, heavy minerals, fine chemicals
- Ceramic colors, pigments, chemical products

contrast. Both types have an external conductive coating that provides a filter capacitor when grounded. The 14NP4A has a metal-backed screen for increased picture brightness.

The tubes employ low-voltage electrostatic focus and magnetic deflection. The anode voltage is 12,000 v. Both tubes are 10⅞ in. high and 13⅞ in. wide. **Circle P21 inside back cover.**

POWER TETRODE
made of ceramic and metal

EITEL MCCULLOUGH, INC., San Bruno, Calif., has announced a new 300-w anode dissipation ceramic power transmitting tetrode. Designated the 4CX300A, the tube is approximately 2½ in. in length by 1½ in. in diameter and was developed specifically for severe environments.

Made entirely of ceramic and metal, and incorporating ceramic support of internal electrodes, the tube produces low noise output despite heavy accelerative forces from shock and vibration. Supported solely at its base by a standard Eimac air system socket it will withstand repeated 11 millisecond 50 g shocks in any plane without internal shorts or mechanical damage. There are no major electrode resonances when the tube is vibrated from 30 to 2,000 cps.

Metal-ceramic construction inhibits deterioration of electrical characteristics while operating continuously at envelope temperatures of 250 C. Also, high temperature processing has produced an

HOW FAST CAN AMERICA STRIKE BACK?

America's defense is keyed to halt aggression almost as soon as it starts. In seconds, bombers of our Strategic Air Command, guided by a *new bombing and navigational system,* will be able to take to the air, seek out, and smash any threat of war aimed in our direction.

Heart of this new bombing and navigational equipment is an electronic computer, built by IBM. With a speed and accuracy never before possible, this computer sifts through reams of flight and target data, translating them into vital facts for a safe and successful mission.

Careers unlimited

If you are an engineer or a technician, perhaps you would like to work on similar computers for business, government and science—as well as for defense. IBM offers unequalled career opportunities in this virtually "unlimited" field of electronics.

Many IBM benefits

In addition to excellent starting salaries and on-the-job training with pay, IBM offers a chance for rapid promotion through its individual merit recognition system. You'll work in some of the choicest locations in all America and enjoy the advantages of IBM's industry-famous employee-benefit policies.

Write,
outlining your background and interests, to: R. A. Whitehorne, Room 411, International Business Machines Corp., 590 Madison Ave., New York 22, N. Y.

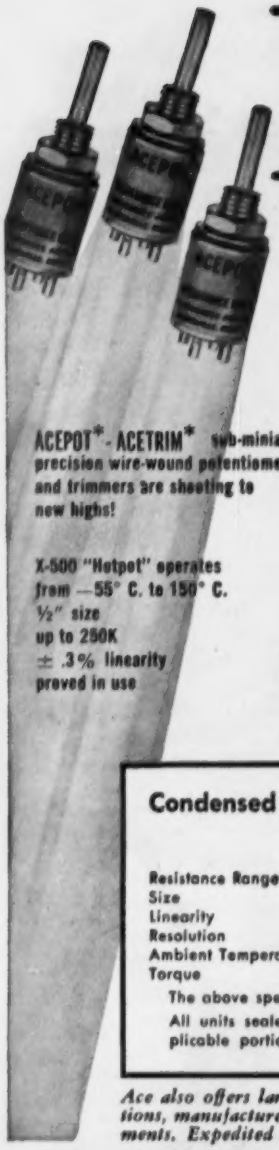
IBM Laboratories at Endicott, Owego, Poughkeepsie and Kingston, N. Y., and San Jose, Calif.

DATA PROCESSING
ELECTRIC TYPEWRITERS
TIME EQUIPMENT
MILITARY PRODUCTS

IBM INTERNATIONAL BUSINESS MACHINES CORPORATION

New

X-500 Sub-Miniature ACEPOT* rated to 150° C.



ACEPOT*-ACETRIM* sub-miniature, precision wire-wound potentiometers and trimmers are shooting to new highs!

X-500 "Hotpot" operates from —55° C. to 150° C.
½" size
up to 250K
± .3% linearity
proved in use

ACEPOTS and ACETRIMS meet unusually rigid functional and physical requirements and are setting new standards for dependability in sub-miniaturization. The designs are the result of 4 years' development and over a year of *successful* use by leading electronic and aircraft equipment manufacturers.

Condensed Engineering Data

	ACEPOT (potentiometer)	ACETRIM (trimmer)
Resistance Range	200 ~ to 250K ± 2%	10 ~ to 150K ± 3%
Size	½ x ½"	½ x ½"
Linearity	±.3%	±3%
Resolution	extremely high	excellent
Ambient Temperature	—55° C to 150° C	—55° C to 125° C
Torque	low or high	low or high

The above specifications are standard — other values on special order.

All units sealed, moistureproofed, and anti-fungus treated. Meet applicable portions of JAN specs and MIL-E-5272A standards.

Ace also offers larger size precision potentiometers, to RETMA specifications, manufactured to highest standards to meet your most rigid requirements. Expedited delivery from special order section.

For applications where you must be positive, answer your potentiometer and trimmer needs with space and weight saving, highly accurate and dependable ACEPOTS and ACETRIMS.

Available in threaded bushing, servo, flush tapped hole or flange mounts, and ganged units. Special shaft lock is self-contained. Internal stops and taps as required. Indexing pin provides non-rotational mounting.

Expedited delivery on prototypes; prompt servicing of production orders. Write for Fact File and application data sheets.

*trademarks applied for

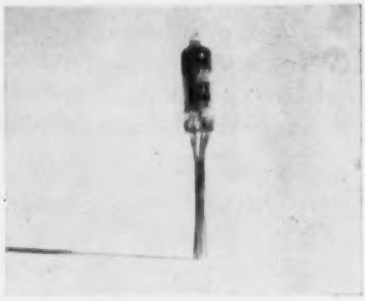
ACEPOT* ACETRIM*

ACE ELECTRONICS ASSOCIATES

Dept E, 101 Dover St. • Somerville 44, Massachusetts

extremely clean tube with more thorough outgassing.

The 4CX300A operates at full ratings through 500 mc—500 w input as a r-f amplifier or oscillator, and 300 w input as a plate-modulated r-f amplifier. **Circle P22 inside back cover.**



SUBMINIATURE TUBE
for guided missiles

SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y. Type 6788, a T-3 subminiature sharp cutoff audio voltage pentode amplifier, was designed for guided missile applications. It is also expected to find utilization in such areas as military vehicular applications and telemetering. The complete line announced includes three other pentodes and three triodes. **Circle P23 inside back cover.**

ROTARY ACTUATOR
for airborne applications

WHITE-RODGERS Co., 4407 Cook St., St. Louis 13, Mo., has developed a new 400-cps servo controlled flat package actuator designed for air-

Photo courtesy of Associated Spring Corp.

Need a spring for service above 500° F.?

When it is a question of strength and resistance to fatigue and relaxation under corrosive conditions—

Particularly when temperatures range over 500°F. and other materials do not perform satisfactorily—

That is the time to see how INCO Nickel Alloys may solve the problem for you.

Inconel and Duranickel, for example, are widely used for springs that must resist relaxation at stresses up to 70,000 psi and temperatures up to 650°F.

Inconel "X" goes even further. It maintains 90 per cent of its room-temperature mechanical properties up to 900°F., 80 per cent up to 1100°F. Combines excellent resistance to heat, corrosion, and *relaxation* at stresses up to 100,000 psi. (Maximum recommended design stress, corrected, decreases as heat exceeds 700°F.)

Other Inco Nickel Alloys—Monel, "K" Monel, Permanickel® — help solve special spring problems. Permanickel, for example, combines good electrical conductivity with excellent heat and fatigue resistance.

Why don't you let Inco engineers help you find the right spring for severe service.

INCO Nickel Alloys

TRADE MARK

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL "S"® MONEL • INCONEL® • INCONEL "X"® INCONEL "W"® • INCOLOY® • NIMONIC® Alloys NICKEL • LOW CARBON NICKEL • DURANICKEL®

THE INTERNATIONAL NICKEL COMPANY, INC.
Electrical and Electronic Section E-11-56
67 Wall Street, New York 5, N. Y.

I need springs that will last longer in ☐ corrosive conditions ☐ high temperatures. Please send me your new booklet on "Inco Nickel Alloy Helical Springs".

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Company_____

Company Address_____

You Can Have Precision Parts with

10,000,000,000,000 MEGOHMS per cm³ VOLUME RESISTIVITY

by specifying DIAMONITE high alumina ceramics

with all these highly-developed properties, too!

The ultra-high volume resistivity of Diamonite, even at very high temperatures, together with its other highly developed dielectric properties as shown at the right, offer many opportunities for improved electronic design and performance.

Its absolute zero water absorption factor insures uniform performance under all atmospheric conditions and its highly developed physical and thermal characteristics often solve vexing problems.

PROPERTIES AVAILABLE IN DIAMONITE

Composition	to 97% Al_2O_3
Tensile Strength	to 28,500 p.s.i.
Modulus of Rupture	to 49,500 p.s.i.
Compression Strength	to 500,00 p.s.i.
Impact Resistance	.23 / .25 Izod
Specific Gravity	to 3.82
Pore Volume	less than 1%
Softening Temperature	1850°C
Thermal Conductivity	.02 cal/sec/cm²/cm/°C.
Average Co-efficient Thermal Expansion cm/cm/°C	25°/700°C 7.3x10⁻⁶
Volume Resistivity, Ohms per CM³	**250°C 2.0x10¹⁴** / **500°C 1.3x10¹¹**
Te Value Vol. Res. 1 megohm	over 1,100°C
Dielectric Constant K @ 25°C	10¹⁰ ~ 8.77
Dielectric Loss Factors	25°C 10⁹ ~ .0009
Hardness	Mohs 9+
Water Absorption*	Absolute Zero
Thermal Shock Resistance†	over 1,000°C

* Determined Electrically after 48 hours immersion in water.

† Withstands repeated heating to this temperature and air quenching without loss of strength.

If you require precision parts, however intricate in design and in any quantity, embodying these unique properties, Diamonite's electronic and ceramic engineers and product development facilities are at your service in working out details of the application.

DIAMONITE products manufacturing company
Canton 2, Ohio

REPRESENTATIVES IN PRINCIPAL CITIES

borne applications. This rotary actuator is designed to be operated from magnetic, transistor or v-t amplifiers, and can be supplied in two output torque ratings: 100 in. lb at stall and 50 in. lb at 1.8 rpm, or 50 in. lb stall and 25 in. lb at 3.6 rpm.

This actuator is available either with or without a-c tachometer feedback for stabilization purposes. Position feedback may be provided by either internal potentiometer or synchro signals. Internal fixed stops and limit switches can be incorporated if required.

Maximum overall dimensions excluding shaft extension is 6 in. wide, 3⅞ high and 1¾ in. deep. External electrical connections are made by means of an AN type connector mounted either on the side or recessed in the back of the actuator. **Circle P24 inside back cover.**

LIGHTWEIGHT TWT
for military aircraft

SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y., has announced the TW956, a new lightweight traveling-wave tube for military aircraft. The 2¼ lb device is 80 percent lighter than heavy equipment, also illustrated, performing the same function. It utilizes a system of permanent magnets for focusing instead of solenoids requiring electric power. The new device combines the tube and focusing

Model 770: Wide Band DC Amplifiers (0 to 5 MC). 10 MV RMS per inch sensitivity. New flat-face 5" tube permits a more linear reading as well as facilitates photography for permanent records of any pattern or series of patterns. An illuminated calibrated screen is backed with a green filter which reduces reflections. Excellent pulse response, built-in voltage calibrator and unusual stability are features every engineer will appreciate.

Model 387R: Industrial's 3" scope in a rack mount style with identical horizontal and vertical amplifiers. DC to 500 KC response and a 10 MV RMS per inch sensitivity. Recurrent and driven sweep, internal or external locking, non-frequency discriminating ten-to-one gain control, full screen deflection without low or high frequency distortion are ideal features designed to permit versatile use of this equipment in all phases of electronic work.

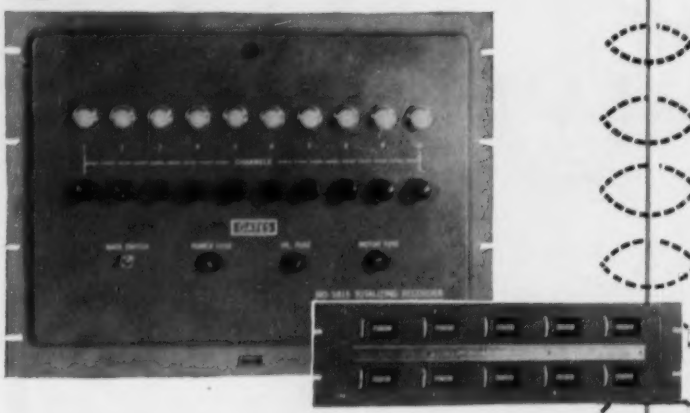
Model 675: Features a vertical wide band frequency response from 1 cycle to 4.5 megacycles, at a 20 MV RMS per inch sensitivity. A new type circuit technique has replaced the need for dual sensitivity. The vertical attenuator is frequency compensated in decade steps. The recurrent sweep has a frequency coverage from 10 to 100,000 cycles with vernier control. Illuminated calibrated screen and other features qualify the 685 as a high-quality 5" 'scope.

Your inquiry is invited. Technical details are available at your request.

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
10527 DUPONT AVENUE • CLEVELAND 8, OHIO

GATES

Totalizing Recorder

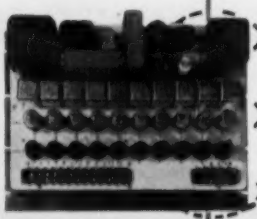


A precision instrument used to record the time a signal is at or above a pre-selected value. Widely employed in measuring field intensity in propagation tests.

Operates from the rectified output of any good quality receiver. Input voltage range is 0 to -10 volts DC. Sensitivity is guaranteed to .05 volts DC input through average readings to .005 volts are not unusual. Any of 10 channels may be set at varied voltage ranges. Isolation between channels permits closeness to .05 volts without interaction.

Each channel, when energized, operates a 1 RPM synchronous motor driven counter reading in 1/10 minutes and totaling to 9,999.9 minutes.

Full detail in the Gates 300-page catalog, Page 235.



Gates M3815 Totalizing Recorder; rack panel size 19" x 14" and 5¼" x 19". Drop down to service front panel. For 115 volts, 60 cycles. Price, F.O.B. Quincy, Illinois, $1375.00.

GATES RADIO COMPANY

MANUFACTURING ENGINEERS SINCE 1922

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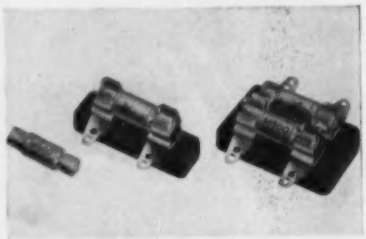
apparatus in a single lightweight package. **Circle P25 inside back cover.**

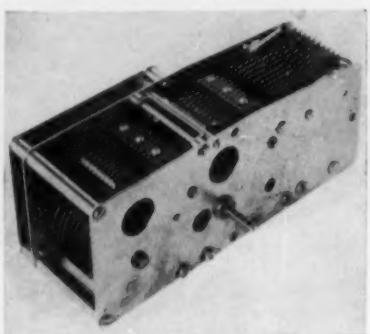


SILICON RECTIFIER

a new fuse-type unit

SARKES TARZIAN RECTIFIER DIVISION, 415 N. College Ave., Bloomington, Ind., has announced a new fuse-type silicon rectifier to replace all selenium rectifiers in radio, tv and electronic devices. The rating of the unit is 400 v back at 500 ma. Overall dimensions are ¼ in. in diameter and approximately 1 in. long. It will fit into a standard fuse holder.

Further information is available from the company. **Circle P26 inside back cover.**



CONVERTER

analog-to-digital type

FISCHER & PORTER CO., 809 Jacksonville Rd., Hatboro, Pa., has available its shaft position, analog-to-digital converter, the Digi-Coder, now available in a new C-2-B model.

The advanced-design unit incorporates, at a lower cost, many new features, such as reduced inertia, wide range of a-c and d-c operating voltages, and noncorrosive, precious-metal contacts. The

You owe it to yourself *and your family to compare these multiple advantages offered only by Consolidated . . .*

Find out now how CEC's engineers enjoy a combination of advantages unique in electronics, and made possible by executives with both scientific and professional management backgrounds. CEC's policy of recognition for the individual has built a pioneering, multi-million dollar organization—the recognized leader in the application of electronics to chemical analysis, process monitoring, dynamic and static testing, and automatic data processing...

YOUR CREATIVE IMAGINATION PAYS OFF AT CEC

In development engineering laboratory, George M. Slocomb (center), 31, supervisor of digital data processing section, explains new test procedure in transistor circuitry for digital data handling. Viewing breadboard demonstration are engineers Bob Kelly (left) and Wayne Hodder. *CEC's substantial R&D budget is 2-3 times greater than normal budgets—totals 10-15% of sales.*

TOP MONEY for professional engineers in all classifications: Development, Design, Systems, Test and Service. CEC's fast, continuing growth offers great opportunity in a stimulating professional atmosphere.

HOW TO ENJOY YOUR WORK and make your family happy . . . CEC's progressive administration emphasizes *excellent working conditions in modern buildings. Your family will enjoy the beauty of CEC's non-industrial location!*

PROFIT SHARING SECURITY *plus* exclusive life, health, accident plans. CEC's profit sharing enables you to participate in the Company's growth—backed by rising sales ($17.1 million in 1955...$23 million anticipated in 1956).

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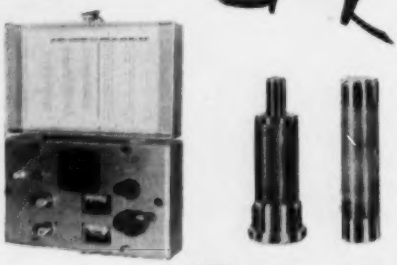
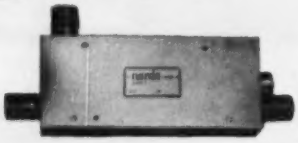
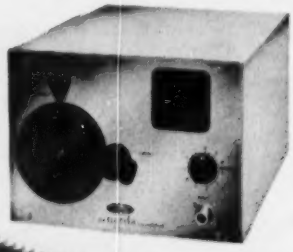
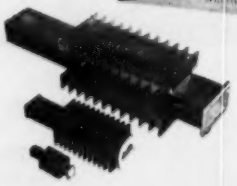
STANDARD REFLECTIONS

From L Band (1120-1700mc) to KA Band (26,500-39,500mc)









Ask for catalog

Narda also makes a complete line of bolometers and thermistors, available for same-day delivery

the narda corporation

160 HERRICKS ROAD, MINEOLA, N. Y., PIONEER 6-4650

COMPLETE INSTRUMENTATION FOR MICROWAVE AND UHF

latter may be used to make and break a circuit at 250 ma, 48 v d-c, or 115 v a-c.

These improvements and others result in a unit with a life expectancy 20 times greater than any other shaft position, analog-to-digital converter now available. **Circle P27 inside back cover.**

SUPPLY
for transistor circuits

SORENSEN & CO., INC., 375 Fairfield Ave., Stamford, Conn., has introduced a variable voltage, low cost supply especially designed for transistor circuit work. The T-Nobatron, model T-50-1.5, features excellent line voltage regulation and transient response for line and load pulses.

▶ **Specifications**—Input range of the unit is 95-130 v a-c, 60 cps. Output voltage is 0-50 v d-c in 3 ranges, 0-10, 0-25 and 0-50 v. Regulation for line changes is ±1 percent for 105-125 v, ±2 percent for wider input. Ripple is 50 mv maximum.

Complete specifications, performance data and quotations are available. **Circle P28 inside back cover.**

IGNITRON TUBE
controls resistance welders

WESTINGHOUSE ELECTRIC CORP., Electronic Tube Division, Box 284, Elmira, N. Y. Type WL-5822-A ignitron tube, for control of frequency-changer resistance welders, is a sealed, stainless-steel jacketed, water-cooled, mercury-pool tube capable of intermittent

RCA "SPECIAL RED" AND "PREMIUM" TUBES

Optimum performance of electronic equipment, particularly when it involves critical applications, often depends on the quality of the tubes installed in the equipment. *Premium-quality* tubes minimize early failures and inefficient or unreliable equipment performance.

The ability to design and manufacture a *premium-quality* tube comes only with the accumulation of many years of experience in the development and production of tubes of all types. RCA's special knowledge of tube design, manufacture, inspection, and quality control is diligently applied in producing RCA PREMIUM TUBES. This special knowledge is your assurance of electron tube dependability and optimum performance of your equipment.

Design for dependability. In critical applications, *specify* "SPECIAL RED" and "PREMIUM" TUBES—available through your RCA TUBE DISTRIBUTOR. For technical data on RCA "Special-Red" and "Premium" tubes, write RCA, Commercial Engineering, Harrison, N. J.

TUBES FOR INDUSTRIAL-ELECTRONICS

Radio Corporation of America, Harrison, N. J.

Prototype	RCA "Special-Red" and "Premium" Types
0A2	0A2-WA*
0B2	0B2-WA*
2D21	2D21-W*
6AC7	6AC7-W*
6J4	6J4-WA*
6AK5	5654
6AK5	5654/6AK5-W*
6AK5	5654/6AK5-W/6096*
2C51	5670
—	5686
—	5690†
6SL7-GT	5691†
6SN7-GT	5692†
6SJ7	5693†
—	5718
5718	5718-A*
—	5719
5719	5719-A*
6AS6	5725
6AL5	5726
6AL5	5726/6AL5-W*
6AL5	5726/6AL5-W/6097*
2D21	5727/2D21-W*
6BA6	5749
6BE6	5750
12AX7	5751
12AX7	5751-WA*
12AU7	5814-A
12AU7	5814-WA*
—	5840
5840	5840-A*
6AQ5	6005
12AY7	6072
0A2	6073
0B2	6074
6AS7-G	6080-WA*
6J5	6101
6J6	6101/6J6-WA*
6AU6	6136
6AG5	6186/6AG5-WA*
12AU7	6189/12AU7-WA*
12AT7	6201
5840	6205*

NOTE: Since the "Special-Red" and "Premium" types can not always be used as replacements, check tube data before replacing a type in the prototype column with the listed "Special-Red" or "Premium" type.

†Special-Red Tubes

*Built to the military specification applicable at the time of production.

Want more information? Use post card on last page.

REVERE Thermocouple Wires

bought FIRST because they LAST

Day in, day out . . . in aircraft, refinery vessels, fire protection systems, furnaces, molding presses . . . under extremes of heat and cold, moisture, chemicals and abrasion, Revere thermocouple wires stand up because they're tailor-made for each application.

Solid or stranded chromel-alumel, iron-constantan and copper-constantan conductors available in various gauge sizes. Wrapped, carded or extruded insulations include polyethylene, vinyl, nylon, Revcothene*, Teflon†, fiber glass, asbestos and pure silica glass fiber. Outer braids treated with flame and abrasion resistant saturants. Metallic braids for severe service. L & N, SAMA or NBS calibration. Wires constructed to Military Specifications MIL-W-5845, MIL-W-5846 and MIL-W-5908.

Whether your application requires extreme flexibility, chemical inertness or resistance to temperature, flame, abrasion, moisture, acids or solvents, a standard or special Revere thermocouple wire will meet your specific need.

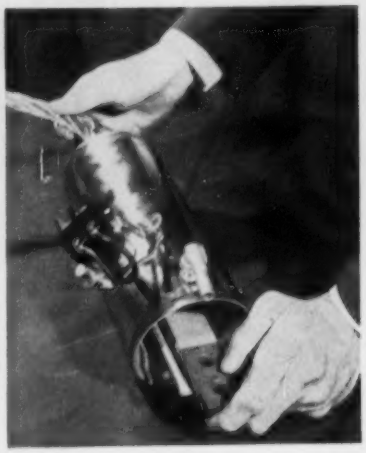
*Revere trade name

†E. I. DuPont trademark

Send for Engineering Bulletin No. 1701 describing Revere Thermocouple Wires and Extension Leads.

Revere CORPORATION OF AMERICA 21

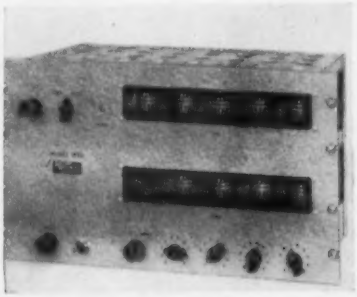
WALLINGFORD, CONNECTICUT A Subsidiary of Neptune Meter Company



ignitor service. It has a 1,200 or 1,500 v maximum anode voltage rating with 1,500 or 1,200 ampere maximum anode current.

It features a provision for the thermostatic control, which when equipped with suitable thermostatic switches, conserves cooling water consumption and simultaneously protects the tube and associated equipment from overloads and overheating.

Overall length including leads is 25 in., and the diameter is 4¼ in. The unit weighs only 8¼ lb. **Circle P29 inside back cover.**



PRESET WAVE TIMER
designed for the laboratory

RANSOM RESEARCH, P. O. Box 382, San Pedro, Calif. Model 1430 preset wave timer is capable of measuring l-f signals with five place accuracy as indicated on the faces of the direct reading counter tubes. For example, a 400 cps signal can be measured to within ±10 μsec, or 5 places, instead of 3 places with the usual ±1 count.

The instrument consists basically of a 4-decade preset counter

IMPORTANT DEVELOPMENTS AT JPL

The Jet Propulsion Laboratory is a stable research and development center located to the north of Pasadena in the foothills of the San Gabriel mountains. Covering an area of 80 acres and employing 1550 people, it is close to attractive residential areas.

The Laboratory is staffed by the California Institute of Technology and develops its many projects in basic research under contract with the U. S. Gov't.

Qualified personnel employment inquiries now invited.

Pioneers in Guidance Systems

For many years the Jet Propulsion Laboratory has pioneered in the design and development of highly accurate missile guidance systems, utilizing the most advanced types of gyroscopes, accelerometers and other precision electro-mechanical devices. These supply the reference information necessary to achieve the hitherto unattainable target accuracies sought today.

The eminent success of the early "Corporal" missile flights shortly after World War II firmly established the Laboratory as a leader in the field of missile guidance. These flights also initiated experiments involving both inertial and radio-command systems employing new concepts of radar communication. Because of this research and experimentation JPL has been able to add materially to the fund of knowledge available to designers of complex missile systems.

This development activity is supported by basic research in all phases of electronics, including microwaves and antennas, new circuit elements, communications and reliability in addition to other branches of science necessary to maintain a fully integrated missile research organization.

The Jet Propulsion Laboratory, therefore, provides many challenging opportunities to creative engineers wishing to actively apply their abilities to the vital technical problems that require immediate and future solution.

We want to hear from men of proven ability. If you are interested please send us your qualifications now.

JOB OPPORTUNITIES IN THESE FIELDS NOW

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MECHANICAL ENGINEERING

JET PROPULSION LABORATORY

A DIVISION OF CALIFORNIA INSTITUTE OF TECHNOLOGY
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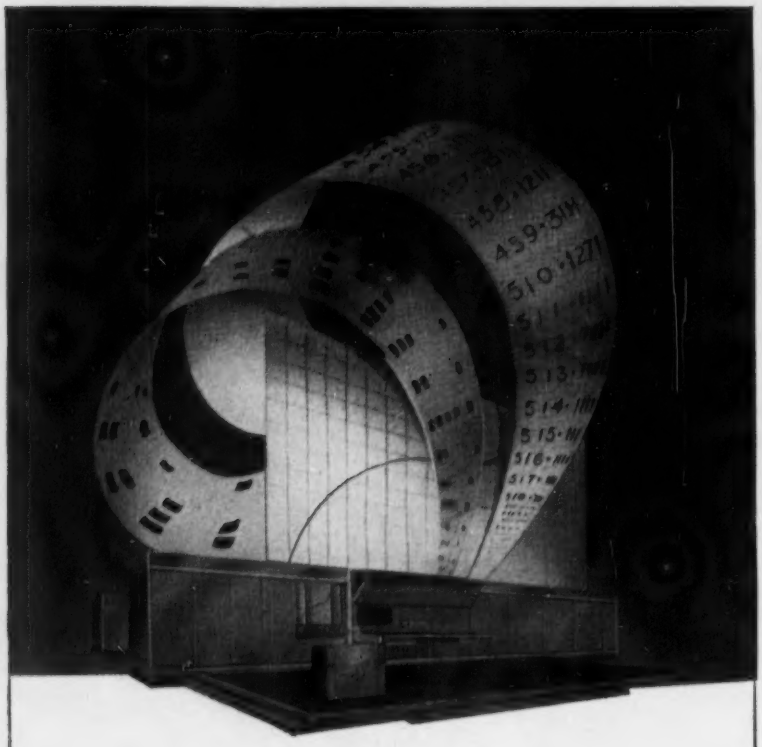


To another problem barrier... **ADIOS**

Progressive engineering from PACE has passed another milestone toward the elimination of tedious, time-consuming manual programming operations. ADIOS (automatic digital input-output system) is the latest development from Electronic Associates, Inc. with characteristic optimum reliability, versatility and accuracy.

ADIOS facilitates the programming and read-out of PACE's precision analog computing equipment by making it completely automatic to:

1. Adjust attenuators to 4-digit accuracy.
2. Adjust diode function generator potentiometers.
3. Read-out attenuator settings.
4. Read-out the ouput voltages of all operational components.
5. Read-out results of both static and dynamic problem check.

ADIOS is controlled either by keyboard or punched paper tape. Setting or read-out of components is entirely by selection as both sequences are controlled by auxiliary tape. Permanent record of operations is provided with an electric typewriter and a tape punch. The digital voltmeter part of the read-out system has a visual indicator so that all operations can be monitored by the operator.

Your inquiries are invited for detailed information on ADIOS, PACE computing systems, time-rental at our Princeton Computation Center or a visit with our skilled Sales Engineering Staff. Write Department EL-11, Electronic Associates, Inc., Long Branch, New Jersey.

ELECTRONIC ASSOCIATES Incorporated • • • SETS THE PACE (PRECISION ANALOG COMPUTING EQUIPMENT)

LONG BRANCH, NEW JERSEY · TELEPHONE LONG BRANCH 6-1100

and a 5-decade precision timing unit. Frequency range is 1 cps to 20 kc with square wave input or 20 cps to 20 kc with sine wave input. The preset count capacity is up to 9,999; the precision timer range is up to 1 sec in 10 μsec increments; and the timing accuracy is ±10 μsec. **Circle P30 inside back cover.**

PRECISION POT
is 3 in. in diameter

HELIPOT CORP., Newport Beach, Calif. The 3-in. diameter single-turn series 5700 precision potentiometer is a new unit with torque, noise and mechanical runout values considerably improved over the series L.

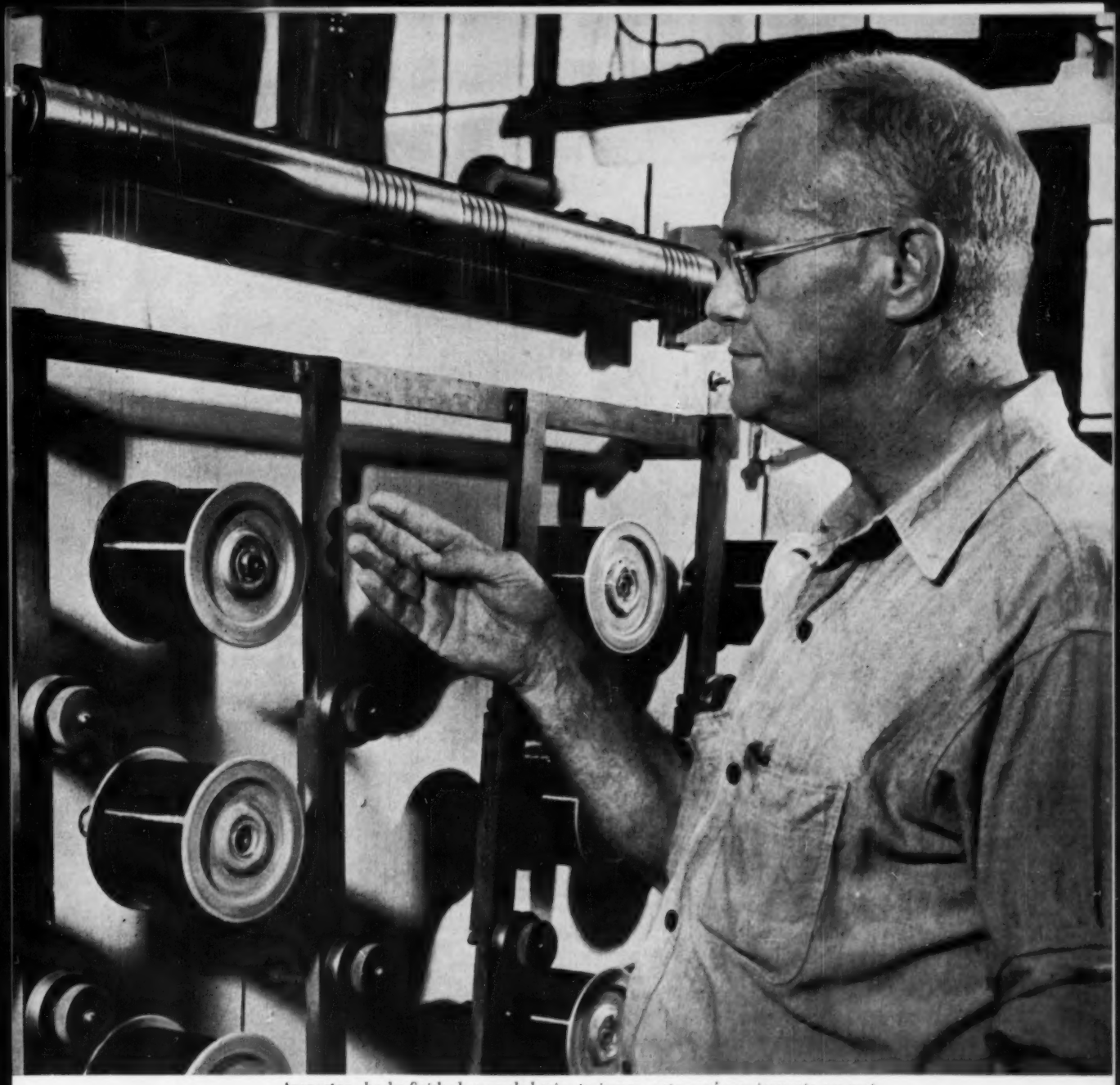
Housed in a dimensionally stable one-piece plastic cup, the 5700 can have 8 sections ganged on a common shaft at the factory . . . each with a maximum of 33 taps.

► **Other Features**—Standard range of resistance is from 50 to 163,000 ohms. Linearity is as close as ±0.1 percent. The unit is available with or without ball bearings, for servo or bushing mounting. Power ratings are 6.9 w at 25 C ambient and 5 w at 40 C ambient. Operating range is from −55 to +80 C.

The series 5700 also offers a wide selection of modifications to meet exact specifications. **Circle P31 inside back cover.**

BINARY DIVIDER
pulses tv synchronizers

LABORATORY FOR ELECTRONICS, INC. 75 Pitts St., Boston 14, Mass. Using the binary storage principle of magnetic cores, the model 1801 Syncpulser is a binary divider



Inspector checks finished enameled wire to insure customers' requirements are met.

THIS MAN CAN HELP YOU

Eliminate cost of incoming magnet wire inspection!

This inspector acts as customers' agent in the Anaconda magnet wire mill.

Result: Anaconda Magnet Wire complies with such exactness to specifications that many customers have felt it possible to *eliminate incoming inspection*... at considerable savings in money, time and manpower.

More than this, customers say Anaconda quality control pays off in smoother winding room performance . . . and helps them produce a consistently high quality product at lowest cost.

Talk to the Man from Anaconda about a trial run of Anaconda wire to prove it to yourself. Call or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, New York.

66222

ASK THE MAN FROM ANACONDA® FOR MAGNET WIRE

Who Gets the Order—and Why?

If you're the person responsible for buying your company's springs you *know* why. You know the price should be right . . . equal or better. But you know that price isn't the final factor either. You've found that dependability of the supplier is of greater importance. His delivery commitment . . . his assured uniformity of quality products . . . and his engineering and manufacturing organization that can help solve unusual problems that so often save time and final costs. It's these things that spring buyers keep in mind when the supplier's name is put on the order.

Lewis' name goes on the "P.O.'s" of so many large companies for one or maybe all of the reasons mentioned above. We're proud of that—and we are certainly going to make sure that all of our present and future spring buyers have the same important reasons to put "Lewis" on the order—and more too, if we can find them. How can we help you?

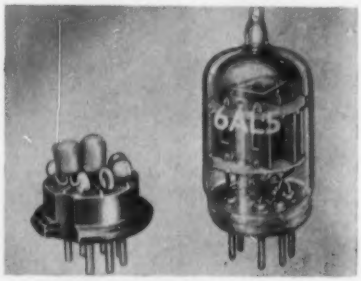
LEWIS SPRING & MANUFACTURING COMPANY
2656 W. North Avenue, Chicago 47, Illinois

Lewis PRECISION SPRINGS

The finest light springs and wireforms of every type and material

circuit which has the unique advantage of avoiding the set-up adjustments and maintenance of ordinary dividers. It is designed primarily as a subassembly for use in the synchronizers of tv broadcast equipment. In this application it gives a 525 count synced to 60 cps, but units can be constructed for applications requiring other counts.

The 32.5 kc output is 22 v into 1,000 ohms, the pulses 2 μsec wide at the base. The 60 cps output is a 7 v pulse into a high impedance load. The construction is that of a 7-tube subassembly 7¾ in. by 3¼ in. by 3 in. using the latest in printed wiring techniques. **Circle P32 inside back cover.**

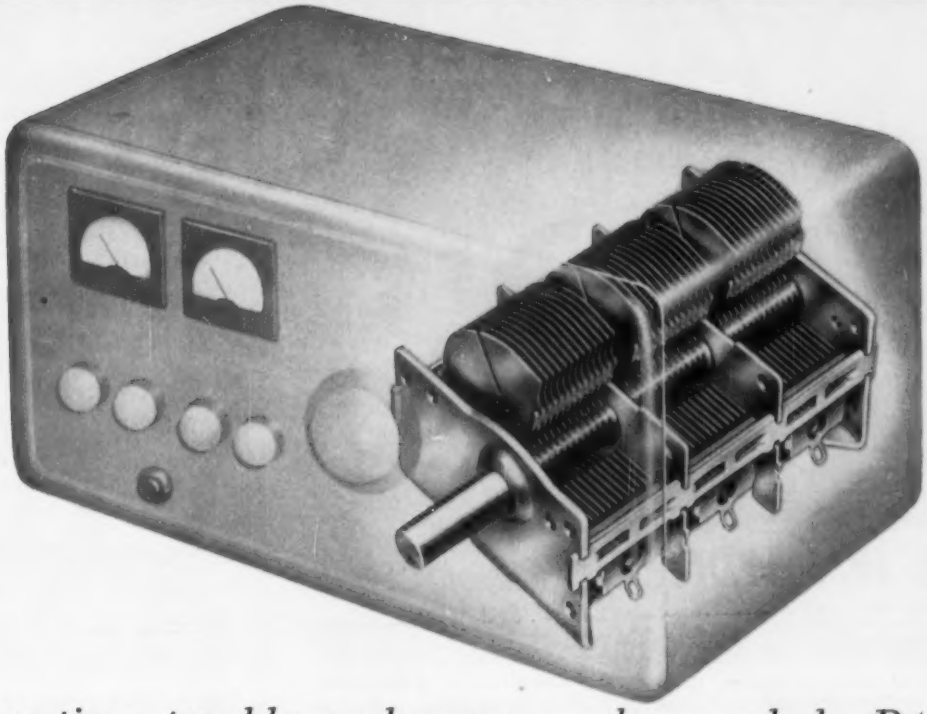


SELENIUM RECTIFIER
compact, plug-in type

INTERNATIONAL RECTIFIER CORP., El Segundo, Calif. Type 60-7788 is a small, compact plug-in selenium rectifier designed to replace the 6AL5 tube in many tv sync discriminator circuits. These subminiature selenium rectifiers do not require any heater power.

This unit consists of two 1U1 selenium diodes, mounted and soldered to a plug that fits a 7-pin miniature tube socket. Each diode is designed to deliver 20 v d-c at 1.5 ma for an rms voltage input of 26 v maximum and may be operated through an ambient temperature range of —50 C to 100 C. The

variable capacitors for electronic instruments



save time, trouble, and expense, when made by R/C

Whether you manufacture frequency meters, grid dip meters, or "Q" meters—sweep generators or communications kits—if it includes a variable capacitor, chances are Radio Condenser can help you.

As a major supplier of tuning devices for thirty-four years, R/C has long manufactured a complete line of standard, special, and custom variable capacitors especially for instrument use. Characterized by quality consistent with the particular end product, these variable capacitors are well suited to rapid, low-cost, quantity production.

Let us know what your requirements are and we'll be happy to send you complete information on the variable capacitors you need. Or, a call to the Radio Condenser Engineering office nearest you will bring a variable capacitor specialist right to your desk.

RC

RADIO CONDENSER CO.

East Coast: Davis & Copewood Streets, Camden 3, New Jersey, EMerson 5-5500
Middle West: 4335 West Armitage Ave., Chicago 39, Ill., SPaulding 2-4411.
West Coast: 1102 Southwestern Avenue, Los Angeles 6, Calif., REpublic 2-8103
Export: International Div., 15 Moore St., N.Y. 4, N.Y., CABLE: MINTHORNE
Canada: Radio Condenser Co. Ltd., 6 Bermondsey Rd., Toronto, Ontario

Want more information? Use post card on last page.

a proven performer always in control

the A. W. HAYDON CO. delayed reset time delay relays

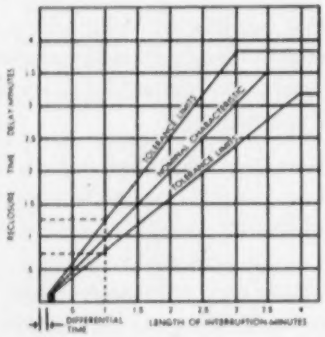
Protect power tubes in expensive transmitting, receiving or control equipment two ways:

1. On initial application of line voltage, the timer operates as a standard Time Delay Relay providing the delay equipment required to get up to correct operating temperature. Therefore, you can throw your load right across the line, and plate voltage will not be applied until filaments or heaters warm up. This eliminates the need for estimating warm-up time, preventing premature tube failures.

2. If line voltage fails, an escapement in the timer operates to provide a Reset Rate which can be calibrated to the cooling characteristic of the equipment. "Down time" is kept to a minimum, and equipment is back in operation as soon as practical after line voltage is restored. This automatic system takes all the "guess" out of operation. You know that no time is wasted — no tube life sacrificed by operator error.

Do you have another application where a Delayed Reset is necessary? These timers will undoubtedly solve your problems too!

Shown in the chart is a typical characteristic. In this case the Reset Rate is equal to the Time Delay.



SPECIFICATIONS

1. Operating temperature range: −65°F to 160°F.
2. Vibration: 5-55 CPS with 10g maximum acceleration.
3. Shock: 30g (11ms duration)
4. Hermetically sealed units meet military requirements for fungus, humidity, and salt spray.

Write for Bulletin AWH TD402 describing 6400 Series DC, 11400 Series AC, 24300 Series 400 Cycle

PREFERRED WHERE PERFORMANCE IS PARAMOUNT

See us at the Automation Show Booth 330, Nov. 26 to 30

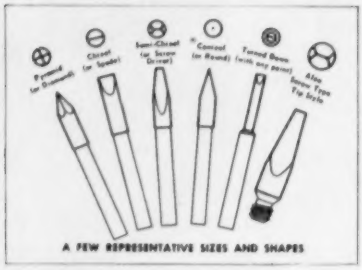
The A. W. HAYDON Company

235 NORTH ELM STREET, WATERBURY 20, CONNECTICUT

Design and Manufacture of Electro-Mechanical Timing Devices

diodes are completely encapsulated within a thermosetting plastic to protect them from moisture, corrosive atmosphere and fungi.

In addition to their application as horizontal sync phase discriminators, in tv receivers, these diodes are ideal components for bias supplies, power supplies for sensitive relays, in computers and in many other circuits. **Circle P33 inside back cover.**



SOLDERING IRON TIPS
expanded long-life type

HEXACON ELECTRIC CO., 130 W. Clay Ave., Roselle Park, N. J., announces an expanded line of long-life Hexclad soldering tips. There are 40 stock sizes and shapes to choose from. Hexclad tips outlast plain copper tips more than ten to one and speed up production.

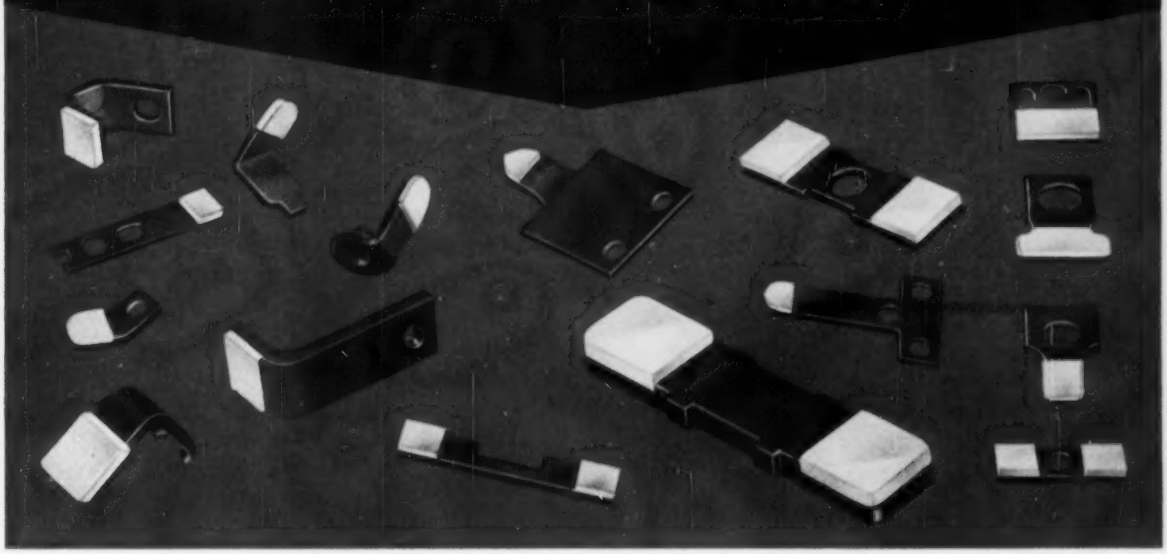
The new tips have a heavy durable coating of iron alloy over copper base on all exposed surfaces for long wearing qualities. Inserted part of the plug tips also have a coating (to protect against oxidation of the copper) which is sufficiently thin so that good heat transfer to the tip is maintained. These tips retain their original shape because they do not erode or pit, thus deliver the same heat consistently for uniform joints. They are furnished tinned ready to use. **Circle P34 inside back cover.**

COAX TERMINATION
precision wideband type

HOLLAND ELECTRONICS, 2133 Central Drive South, East Meadow, L. I., N. Y., has developed a new precision wideband coaxial termination with type N connectors.

The WB50N units feature pre-

NOW...General Plate can give you Silver-Cadmium Oxide Contacts in TOP-LAY Form



General Plate development and volume production of Silver-Cadmium Oxide clad as TOP-LAY now means you can get all of the advantages of Silver-Cadmium Oxide and TOP-LAY combined:

- ★ **Silver-Cadmium Oxide, properly applied, is an outstanding contact material — unusual in its ability to resist arc damage.**
- ★ **High work-hardness and density of both contact facing and backing, blanked or formed from TOP-LAY reduces mass and deformation . . . prolongs contact life.**
- ★ **Thermal and electrical capacities are increased when compared with Silver-Cadmium Oxide contacts made by conventional methods.**
- ★ **The problems of brazing — atmospheres, cleaning and fixturing — are eliminated.**

These Silver-Cadmium Oxide TOP-LAY advantages, plus the many other advantages offered by General Plate clad metal contacts, produce assembly accuracy, design freedom, substantial cost reductions and performance improvements.

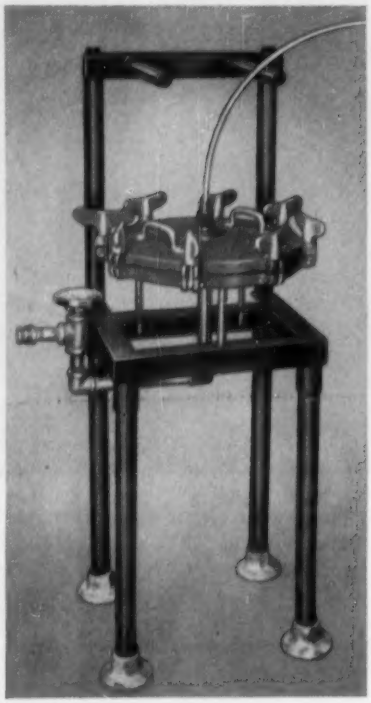
Benefit today from General Plate's new Silver-Cadmium Oxide TOP-LAY . . . for complete information, write for Bulletin 728.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
1311 FOREST STREET, ATTLEBORO, MASSACHUSETTS

ANNOUNCING

For Production of Ultra-Pure Water



THE BARNSTEAD MF SUBMICRON FILTER

Removes Particles to 0.45 micron (.000016 in.)

Here is a new Barnstead aid for the production of extremely pure water . . . a filter that removes submicroscopic particles from distilled or demineralized water. This new filter permits on a production basis an ultra-fine filtration heretofore possible only on a small laboratory scale. The MF Submicron Filter provides positive filtration to 0.45 micron. It removes bacteria. Removal of the submicroscopic particulate matter from the pure water assures better results in work with semi-conductors, transistors, charactron tubes, condensers, reactor components, high resistance cooling systems etc.

Employs replaceable Millipore filtering membrane. Capacities: 100 to 500 or more gallons per hour.

Write for Bulletin 141 for full details on production of water with resistance of 10,000,000 ohms or more, and free of organics, bacteria, and particulate matter.

Barnstead
STILL & DEMINERALIZER CO.

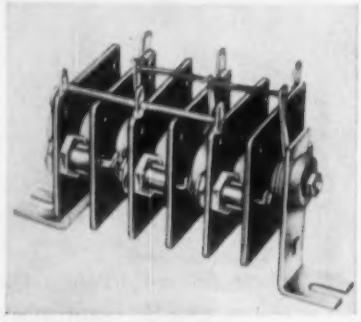
84 Lanesville Terrace, Boston 31, Mass.

Since 1878 — Stills & Demineralizers For Every Pure Water Need

cision film-type resistors in rod form in a specially designed compensated structure providing excellent broadband characteristics with a maximum vswr of 1.1 from d-c to 4,000 mc.

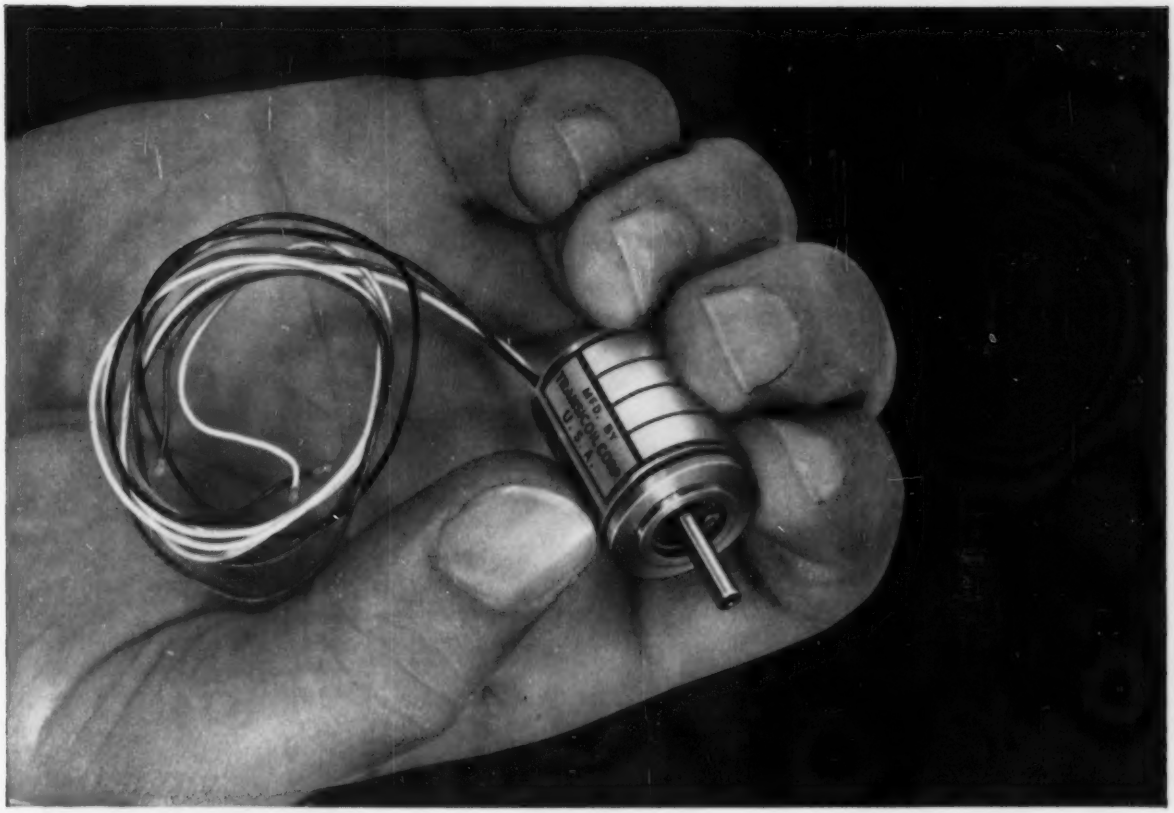
The standard 50 ohm unit correctly matches the output impedance of slotted lines, signal generators and short rise-time pulse generators. Similar units with other resistance values can be supplied to match any special equipment. The units serve also as correct loads for filters, attenuators and directional couplers.

The WB50NM unit includes an AN UG-21B/U (male) connector and the WB50NF unit includes the corresponding female connector (UG-23B/U). Other connector types can be supplied. **Circle P35 inside back cover.**



RECTIFIER STACKS of the silicon type

TRANSITRON ELECTRONIC CORP., Melrose 76, Mass. The TL series of silicon rectifier stacks combines the superior performance of silicon rectifiers with the versatility of stack mounting. They overcome the basic limitations of ger-



NEW MINIATURE SERVO

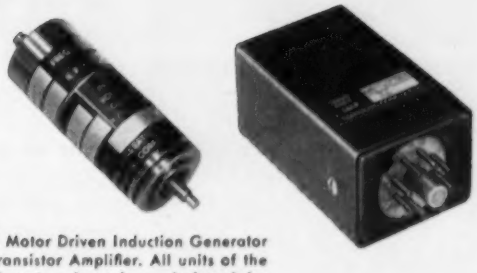
40% Lighter, 10% Smaller

Here, no bigger than your thumb, is the smallest *practical* servo control motor currently produced. Combined with Transicoil's new Size 8 motor driven induction generator, and powered by a new completely-transistorized servo amplifier, this motor offers you the unusually high torque-to-inertia ratio of 28,000 radians/sec^2.

Compared with a Size 9 control motor—until now, the smallest practical unit available—Transicoil's new Size 8 measures only 0.75 inches in diameter, 10% smaller, and weighs only 1.4 oz., 40% lighter. Yet it operates on standard voltages from 26 to 52 volts, and 52 volts with center tap, at 400 cps, permitting push-pull transistor application.

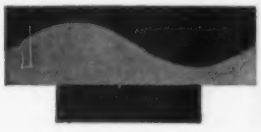
Hence, just as Transicoil's introduction of plate to plate wiring eliminated the transformer, once necessary in servo systems, the Size 8 units and transistor amplifiers mark another milestone in miniaturization.

This is just one more example of how Transicoil can solve your control problems whether they involve miniaturization or control complexity, and go on to manufacture systems and components of the utmost precision and accuracy. You pay only for results—on a fixed fee basis for equipment delivered and performing properly.



Size 8 Motor Driven Induction Generator and Transistor Amplifier. All units of the Size 8 system have been designed for maximum performance in minimum space.

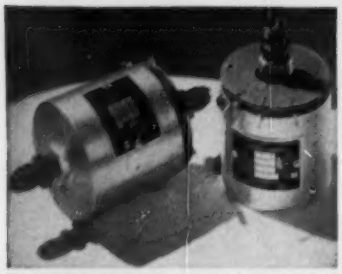
Technical data on the new Size 8 combination and the transistorized amplifier is yours for the asking. But you'll end up with a better system if you write outlining your servo control problem.



TRANSICOIL CORPORATION

Worcester, Montgomery County · Pennsylvania

PRECISION TRANSDUCERS



PRESSURE OPERATED POTENTIOMETERS

Outputs: Linear and nonlinear functions of applied pressure.
Resistances: 100 to 50,000 ohms.
Ranges: 0-5 to 0-5000 psi.
Types: Absolute and differential.
Vibration Ambient: 0 to 55 cps, 0 to 500 cps, and severe vibration 25g to 2000 cps.
Construction: Hermetically sealed.

Write for Pressure Operated Potentiometer Bulletin

ULTRA-SENSITIVE PRESSURE SYSTEM

Output: 50 volts at full scale.
Range: ± ¾ psi, differential.
Resolution: 1 x 10^{-6} psid.
Zero stability: Better than 1 x 10^{-3} psid.

Write for Bulletin EPMS

RESISTANCE BRIDGE PRESSURE PICKUPS

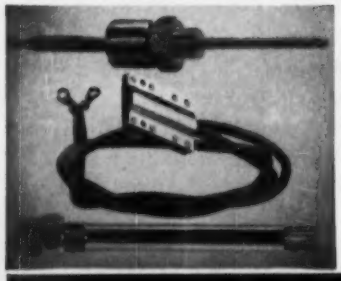
Sensitivity: 5 mv/v at full scale.
Ranges: 0-10 to 0-1500 psi.
Types: Absolute and differential.
Construction: Hermetically sealed.

Write for Bulletin No. 7

RATE OF CLIMB

Outputs: 5 volt signal and/or dial indicator.
Range: ±25,000 ft./min.
Time constant: 0.2 sec. at sea level to 2 sec. at 50,000 ft.

Write for Vertical Speed Transducer Bulletin



RESISTANCE THERMOMETERS

Resistance: 5 to 500 ohms at 32°F.
Materials: Platinum or nickel.
Range: −350 to +2000°F.
Types: Liquid, surface, gas.
Characteristics: Corrosion proof, severe vibration ambient, fast speed of response.

Write for Resistance Thermometers Bulletin

"For Transducers See Trans-Sonics"

Trans-Sonics, Inc.

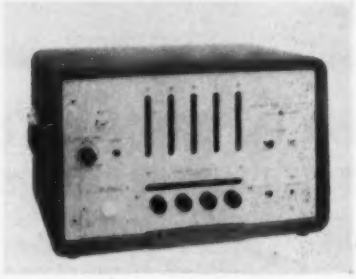
P.O. BOX 328 • LEXINGTON • MASSACHUSETTS

manium, selenium and copper oxide to provide trouble-free operation under severe environmental conditions.

The TL series provides reliable operation at temperatures up to 150 C, and features voltage ranges up to 5,100 v rms, and current ratings up to 10 amperes. Standard stack types are available for single-phase, three-phase and six-phase power supply circuits.

► **Uses**—The series is especially designed to meet the critical requirements of missile, aircraft and other military equipments. Four JAN type rectifiers, the 1N253, 1N254, 1N255 and 1N256, may be optionally incorporated into these stacks.

Complete specifications and ratings are found in the manufacturer's bulletin TE-1342. **Circle P36 inside back cover.**



COMPUTING INDICATOR

with a variable gate time

DYNAC, INC., a subsidiary of Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif. Precise measurements of speed, rpm, pressure, thickness and numerous other quantities can now be read directly in the desired units without time-consuming conversion calculations. The DY-2500 is an electronic counter with a variable gate time that functions as a multiplier of the transducer input to provide direct readings.

► **Features**—Included is a front panel plug-in board that automatically sets any predetermined conversion multiplier. Gate time may also be selected manually and is adjustable from 0.0001 to 0.9999 in 0.0001-sec increments. There is

... or however you express it– that's your business... But – if you're an Electronic Engineer looking for a good position

THAT'S OUR BUSINESS!

DOPPLER AND INERTIAL RADAR SYSTEMS
AIRCRAFT INSTRUMENTATION
AIRBORNE RADAR AND COMMUNICATIONS
DATA PROCESSING EQUIPMENT
DIGITAL COMPUTERS
TRANSFORMER DESIGN

We offer opportunities for advancement within a rapidly expanding medium-size company. You'll benefit from the close personal association of a small laboratory with the versatility of a larger organization.

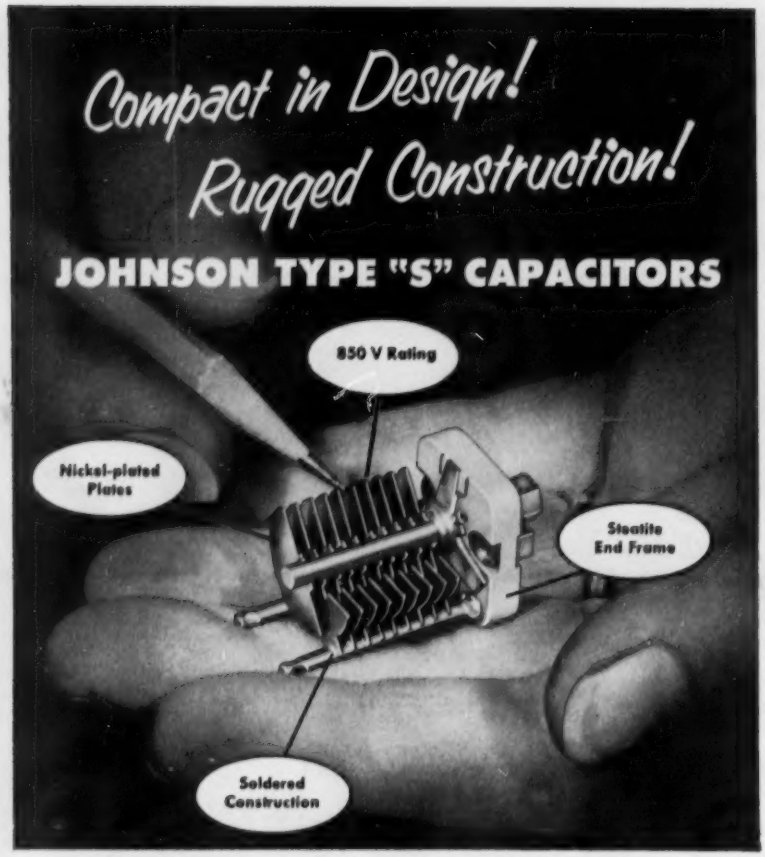
YOU MAY OBTAIN:

▸ *top starting salaries* ▸ *progressive wage reviews* ▸ *better starting positions* ▸ *continuous professional development* ▸ *unique educational advantages* ▸ *full tuition for day or evening study at Boston's leading Universities*

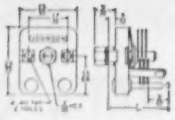
Send your resume or request for additional information to:
DR. M. A. MEYER . . Chief Engineer

LABORATORY FOR ELECTRONICS, INC.

L/E BOSTON 14, MASSACHUSETTS



The Johnson Type "S" capacitor falls midway between the type "M" and "K" capacitors in physical size. Design is compact, construction rugged! End frames are DC-200 treated steatite—plates are nickel-plated brass. Available as a "single" type, the "S" capacitor has a plate spacing of .013" with a peak voltage rating of 850 volts. Other spacings are available on special order. Square mounting studs tapped 4-40 on 17/32" centers. Available with straight shaft, screwdriver shaft, or locking type screwdriver shaft. Single hole mounting types available on special order.



Cat. No.	Type No.	Capacity per Section Max.	Min.	Plates per Sec.	L
148-1	15S8	15	2.3	6	53/64"
148-2	25S8	25	2.6	10	1 5/16"
148-3	35S8	35	2.9	14	1 1/32"
148-4	50S8	50	3.2	19	1 9/64"
148-5	75S8	75	3.9	29	1 13/32"
148-6	100S8	100	4.5	38	1 43/64"

For complete information on all Johnson electronic components, write for your free copy of Components Catalog 977.

STEATITE AND PORCELAIN INSULATORS

Fracture resistant, dense molded and glazed for low moisture absorption. Stand-Off and Feed-Thru insulators designed with extended creepage paths for maximum voltage breakdown ratings. Types available with built-in jacks to accommodate standard banana plugs. Hardware is nickel plated — excellent for exposed applications. Write for full information.

E. F. Johnson Company *Engineers Wanted*

2320 Second Avenue S.W. • Waseca, Minnesota

For unusual engineering and technical employment opportunities...write to our engineering department.

Capacitors • Inductors • Knobs • Dials • Sockets • Insulators • Plugs • Jacks • Pilot Lights

also provision for a second input to permit measuring ratios of two independent variables and direct readings of such quantities as engine revolutions per gallon.

A pushbutton on the front panel permits a quick check of proper operation. **Circle P37 inside back cover.**

HIGH-POWER TRANSDUCER
magnetostriction type

ACOUSTICA ASSOCIATES, INC., Glenwood Landing, L. I., N. Y., has designed a high-power magnetostriction-type transducer for large scale ultrasonic cleaning, degreasing, descaling, plating and other metalworking and finishing operations. This 400 w, 25 kc transducer can be grouped externally on existing process equipment and driven in tandem by electronic or rotary-driven above-audible frequency generators ranging in power from 2,000 to 150,000 w.

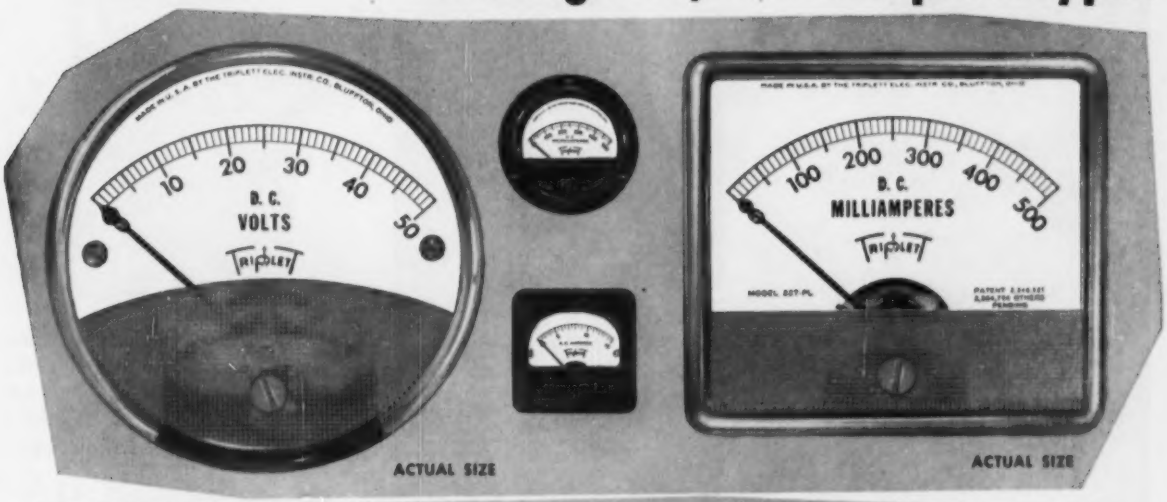
It can be used with liquids at temperatures far above boil point, thus overcoming limitations inherent to barium titanate transducers. The new transducers may well be the answer to many industrial problems in a variety of fields. **Circle P38 inside back cover.**

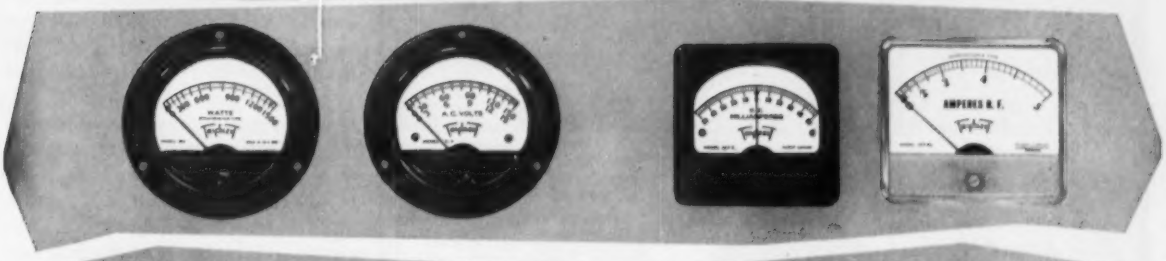
MICROWAVE MULTIPLEX
with plug-in crystals

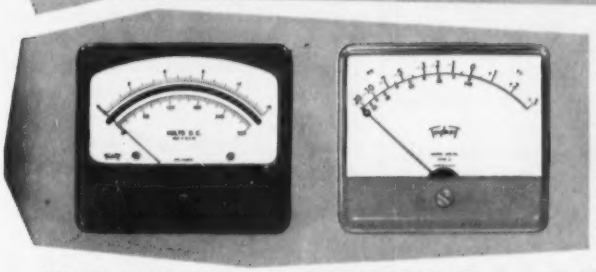
RADIO CORP. OF AMERICA, Camden, N. J., has announced microwave multiplexing equipment designed with simple plug-in crystals for quick, economical channel frequency selection and change.

▶ **Features** — The multiplexing equipment features identical individual channel units which can

TRIPLETT Reliability... through 15,631 accepted types







Clear plastic (PL) meters feature;

- Longer scale length
- Visibility unlimited
- Light unobstructed—no shadows
- Interchangeability—universal
- Appearance revolutionized

UNIQUE FEATURES AND CHARACTERISTICS

These guarantee superior quality in *all* TRIPLETT meters:

- High torque to weight ratio for extra rugged movement. Specially developed bearings withstand severe vibration and reduce friction to a minimum.
- Bearings are microscopically graded not only for depth and radius, but also for *polish*. Only best quality jewels are used.
- Unique hardening method assures uniformly hard pivots.
- High flux scientifically aged alnico magnets for greatest permeability. Micrometrically balanced all metal frame construction protects bearings against vibration from any direction.
- Simplicity of frame construction assures easy, accurate alignment in servicing.
- Dials are all metal—no paper dials are ever used—will not become abrasive, warp, crack or discolor under normal conditions. (Printing presses in Triplett's own plant allow fast, inexpensive service on special dial requirements.)
- Extra strong ribbed pointers precisely balanced with triple "slide and lock" adjusting weights.
- Insulations provide extra allowance for breakdown voltages.
- All metal parts processed, all molded parts pre-cured to eliminate distortions from stresses and strains.

TRIPLETT ELECTRICAL INSTRUMENT COMPANY • 52 years of experience • BLUFFTON, OHIO

Triplett design and development facilities are available for your special requirements for meters and test equipment.

Boston Sunset Advertising

MicroMatch
directional couplers
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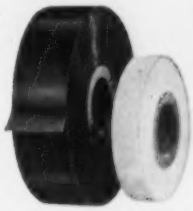

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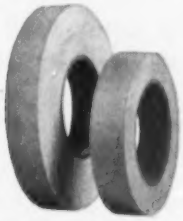

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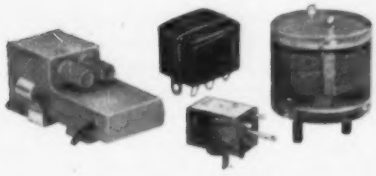

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is completely automatic

ELECTRO INSTRUMENTS, INC., 3794 Rosecrans St., San Diego 10, Calif., has developed a completely automatic digital ohmmeter. With modification L, the new instrument displays 5 digits, presenting quick, accurate measurement which are visually indicated on a true, digital, in-line read-out. Accuracy is within 0.01 percent, ±1 digit, from 0.01 ohm to 100,000 ohms with ranges to 10 megohms at reduced accuracy.

Range is indicated by a lighted, automatically-positioned decimal point and by the symbol Ω or a KΩ in the extreme right window. Average reading time is approximately 1 sec. Overall panel size of the unit is 7 in. by 19 in. It is designed to be mounted in standard racks.

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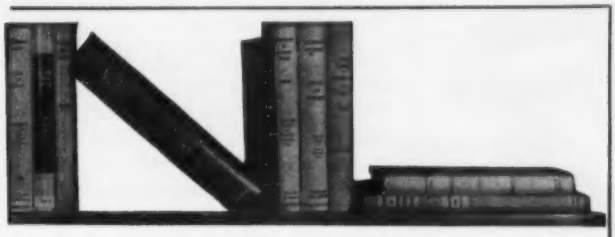

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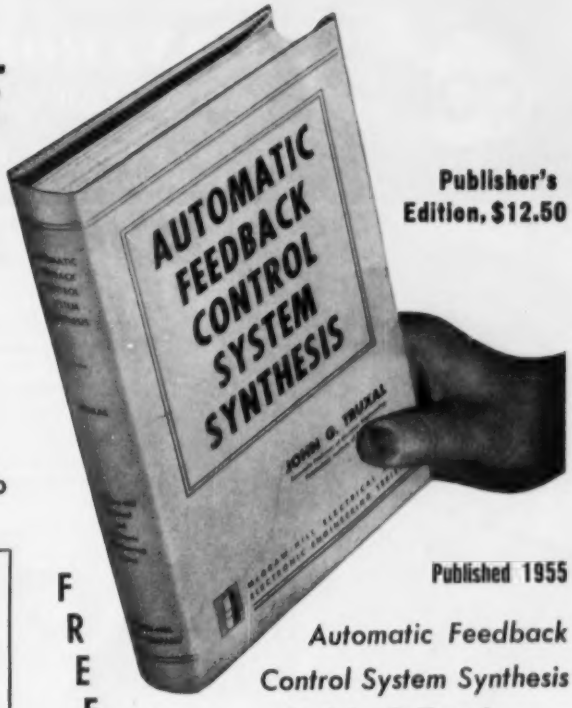

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Associate Professor of Electrical Engineering
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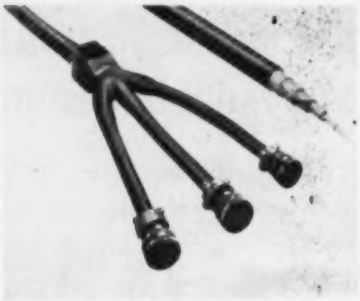


BREAKOUT CABLE
for missile wiring

PACIFIC AUTOMATION PRODUCTS, INC., 1000 Air Way, Glendale 1, Calif. Developed specifically for missile wiring, but adaptable to commercial applications, is a multi-branch multi-conductor breakout cable now being produced. In this breakout are 141 conductors. Although terminating in a 3-branch breakout, this cable permits continuous circuitry as there is no junction in the breakout. Circuits can be completed between any two or all three branches of the breakout without originating in the prime cable.

The cable has a flexibility from −65 F to +175 F. Connectors are sealed against moisture and dirt. Details on the manufacture of this 3-branch breakout and other electronic cable are covered in bulletin 159. **Circle P42 inside back cover.**

COUNTER TUBE
features small size

SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y. Type 6879 miniature cold cathode decade counter tube was developed for specific application in fire control equipment. It is also designed for use in computers and various military equipments, where its small size offers space-saving advantages.

Important decade counter tube features include very low power

The precise answer
to an exacting cable problem

• Special III-conductor telemetering and instrumentation cable developed for guided missile work . . . Cables of the type used for instrumentation and telemetering must operate faultlessly. Dielectric requirements are especially exacting in preventing attenuation of low-level signals.

The project engineers at North American Aviation, Inc., designed a 111-conductor cable that would have the necessary low-loss characteristics, provide trouble-free operation and adequate service life. The cable was used by North American for guided missile work at the Air Force Missile Test Center in Florida.

Electrical characteristics

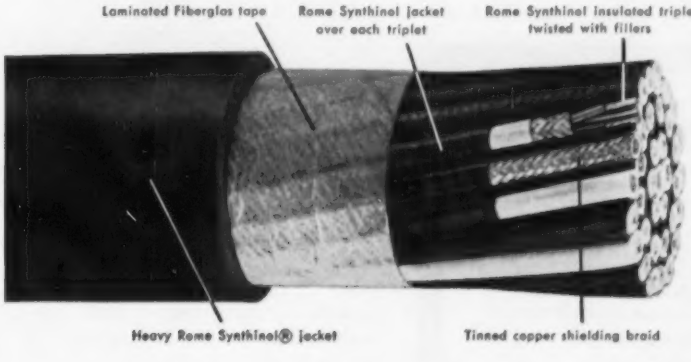
Rigid control of electrical characteristics is of primary importance in the manufacture of this cable. A polyvinyl chloride insulating compound, Rome Synthinol® adequately meets specifications and provides *an economical solution* to specification requirements. Capacitance is controlled by strict adherence to the specified wall thickness of the insulation and by controlled cabling which properly spaces the conductors comprising each of the 37 individually jacketed triplets.

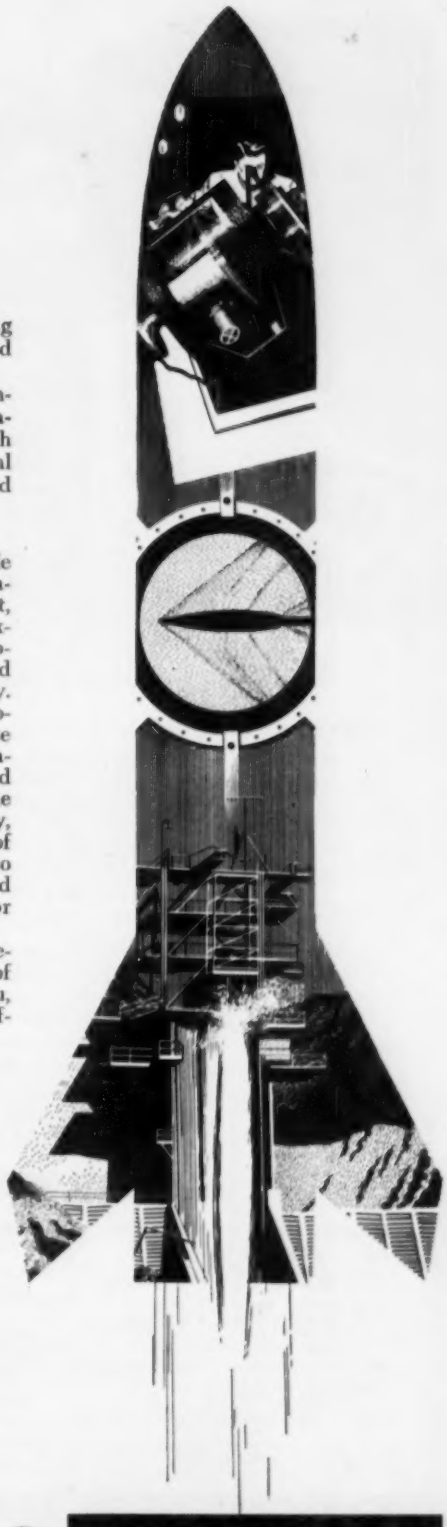
These components and their controlled fabrication prevent attenuation of the low-level signals which this cable is designed to carry—a vital design factor in instrumentation and telemetering cables.

The ingredients of success

Three organizational factors enable Rome to handle tough cable specification problems like this regularly. First, comes engineering competence—experience with electronic circuit problems. Next, production facilities and uncompromising control of quality. (For example, Rome utilizes a photoelectric gauge to maintain close control of diameter limits on insulations and sheaths. This control proved to be especially valuable with the cable described here.) And, finally, comes the unmeasurable factor of production know-how which is so important in meeting exacting and unusual design requirements for multi-conductor constructions.

Designing and manufacturing special cables is a regular occupation of ours. To see how Rome can help you, contact your nearest Rome Cable office or write us direct.


Laminated Fiberglas tape
Rome Synthinol jacket over each triplet
Rome Synthinol insulated triplets, twisted with fillers
Heavy Rome Synthinol® jacket
Tinned copper shielding braid



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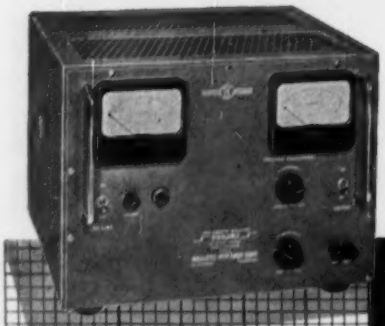

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Output: Voltage Range 5-32V DC; Extended Range 3-36V DC; Current Range 0-15A DC; Short Circuit Current 30A DC
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Ripple: less than 50 millivolts entire voltage range
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Weight: 150 #

REGULATION

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±½% for 0-15A load, 5-32V range	less than 1.5V for 10% load transient
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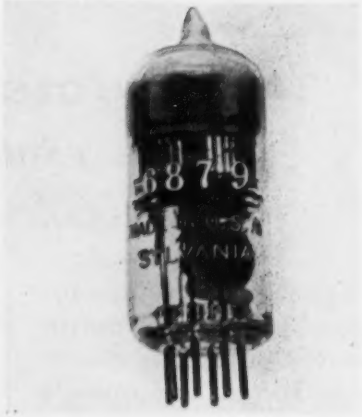
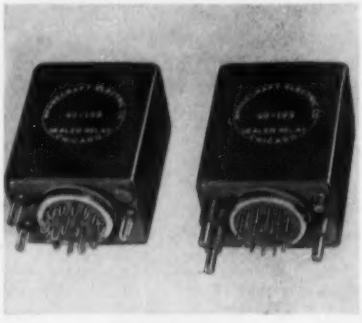


requirements, long life (no filament to burn out), incorporation of a number of functions in one envelope and circuit simplicity.

The 6879 is similar in electrical characteristics to the 6802, except that it has three output cathodes (numbers 0, 8 and 9) instead of four. An output of at least 15 v is provided, and the standard circuitry frequency range is zero to 5,000 pps—up to 10 kc with special circuitry. **Circle P43 inside back cover.**



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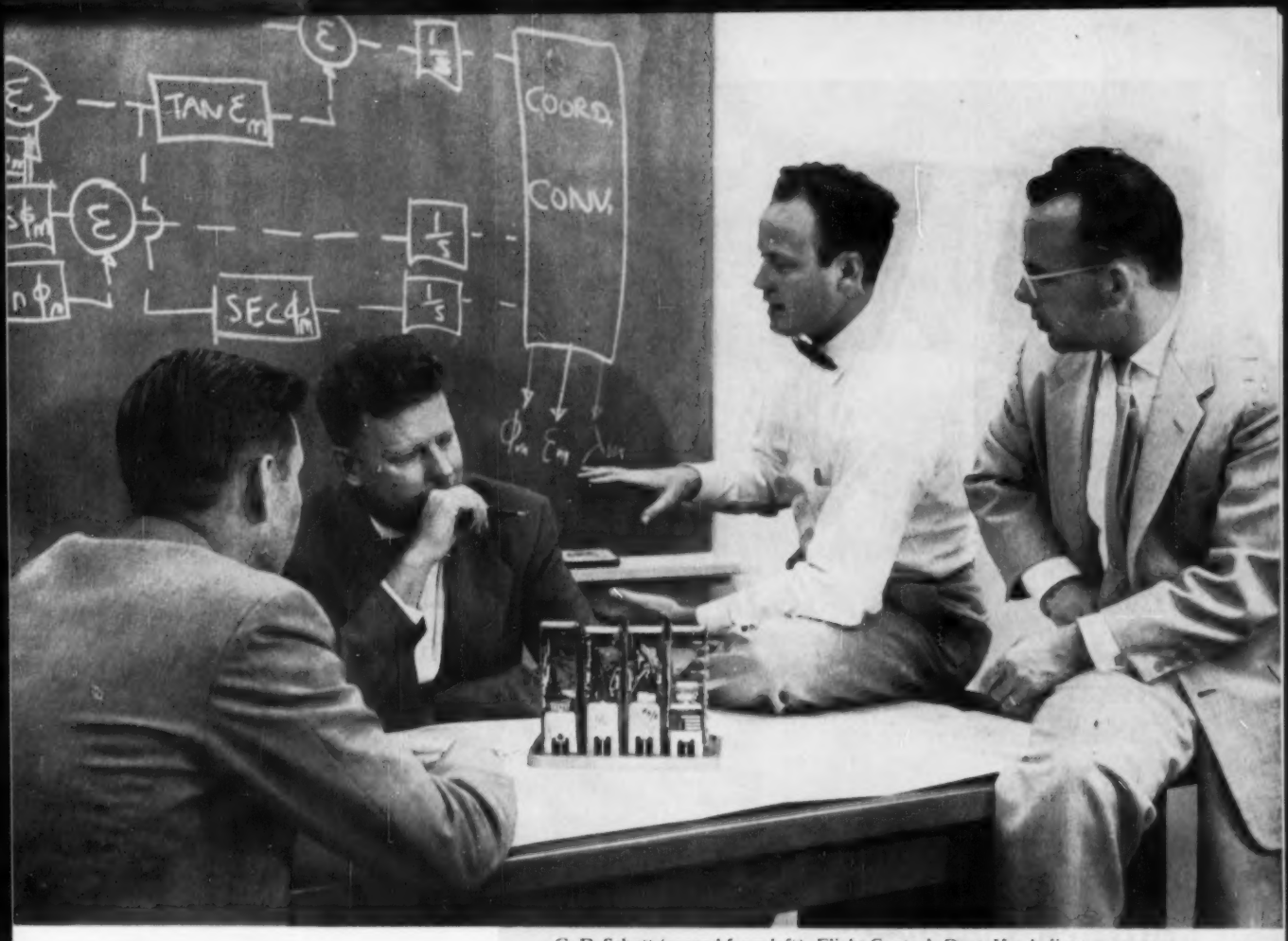
is hermetically sealed

MAGNECRAFT ELECTRIC CO., 3350 West Grand Ave., Chicago 51, Ill. Developed for the reliable switching of a great variety of circuits, a new 6 pdt hermetically sealed relay is available with various contact arrangements and contact rating up to 5 amperes. It can be furnished with specially designed dry circuit contacts.

For d-c operation, it is available in a wide range of coil operating voltages or currents. It is furnished hermetically sealed with 20-pin octal plug or 20-pin solder



G. D. Schott (second from left), Flight Controls Dept. Head, discusses new techniques in the mechanization of autopilots with R. D. Wertz (left), Flight Controls Research Engineer; R. J. Niewald, Flight Controls Analysis Section Head; and B. C. Axley, Servomechanisms Analysis Group Engineer.

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One of the most critical problems encountered in the development of a successful missile system involves attaining rapid responses of controls *consistent with system stability*. Moreover, it is a problem of increasing importance as new aerodynamic configurations require major advances in flight controls performance.

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- Circuit design
- Aerodynamic stability and control
- Flight analysis
- Autopilot simulation

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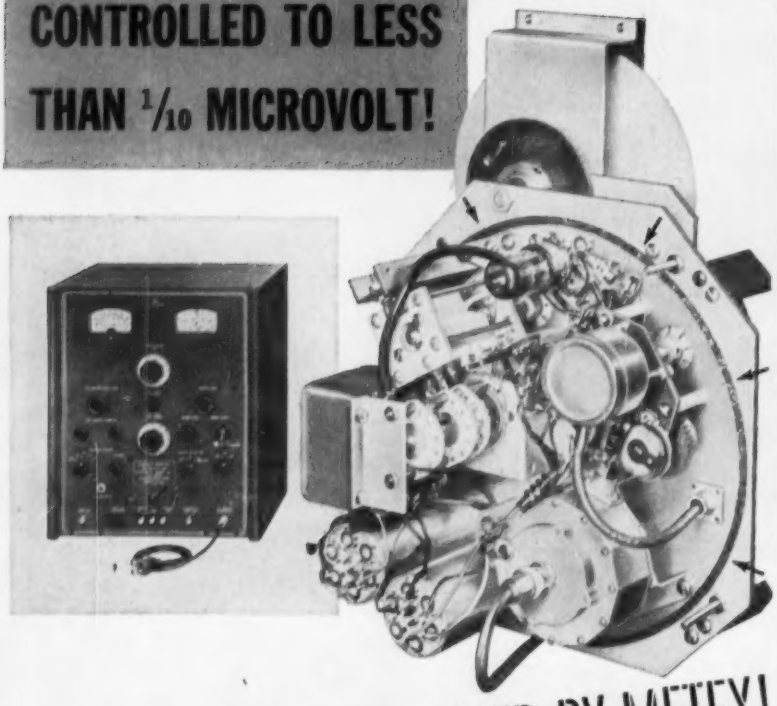

ANOTHER PROBLEM SOLVED BY METEX!

This Type 240-A Sweep Signal Generator built by Boonton Radio Corp., Boonton, N. J., is designed to operate at controlled output levels down to 1/10 microvolt. To prevent RF leakage between the oscillator chassis and oscillator cover, Boonton engineers specified a METEX RF gasket at this critical joint. This METEX RF gasket, knitted of monel wire, prevents RF leakage so successfully that peak performance is obtained at minimum output levels where leakage was previously experienced.

METEX RF Shielding, knitted of monel, aluminum or silver plated brass wire, combines maximum *conductivity* for efficient performance with inherent *resiliency* that assures continuous line contact between imperfect mating surfaces. Interlocked loops, knitted of continuous wire strands, assure maximum *cohesion.*

If you have a problem involving RF shielding in electronics or related equipment, write METEX, today!

ELECTRONICS DIVISION
METAL TEXTILE CORPORATION
ROSELLE, NEW JERSEY

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terminal header. It is also available open or with dust tight enclosure. Descriptive literature may be had on request. **Circle P44 inside back cover.**

FLOW RATE INDICATOR
for logarithmic panel use

FISCHER & PORTER Co., 808 Jacksonville Rd., Hatboro, Pa., has developed an inexpensive flow rate indicator for use with the company's turbine type primary metering elements. Known as the industrial logarithmic panel indicator, the new unit converts the output signal of the turbine meter into a series of pulses of constant amplitude at a frequency equal to that of the turbine meter output and, therefore, proportional to volumetric flow rate.

These pulses are integrated in a d-c milliammeter providing an indication proportional to frequency and hence to flow rate. External terminals are provided for pulse and d-c mv output signals. A shaded pole panel meter with a logarithmic characteristic is employed to provide uniform rate accuracy of 2 percent at a short term repeatability of 0.5 percent of rate. **Circle P45 inside back cover.**

PREAMPLIFIER
vibration pickup type

BRUSH ELECTRONICS Co., 3405 Perkins Ave., Cleveland 14, Ohio. Model BL-1606 vibration pickup preamplifier is designed as a link between Brush accelerometers models BL-4305, BL-4306 and BL-4307 or any type of vibration

NEW MASTER VOLTOHMYST®

Accuracy of
±3% full scale
on both AC and DC

RCA-WV-87B—offers many time-saving work-simplifying features for laboratory, production, servicing—can help improve the quality of your work!

The WV-87B is housed in a durable metal case for general use around the service shop or the lab or for shelf- or rack-mounting on the production line. The unusually large meter face, clearly calibrated scales, and VoltOhmyst circuit permit extraordinary ease and speed in taking highly accurate readings. Helps you work better, faster, more efficiently. You can be positive of the measurements you take when you use the RCA Master VoltOhmyst.

RCA WV-87B Master VoltOhmyst—newest addition to the world-famous line of RCA superior-quality Test Instruments—is available through your RCA DISTRIBUTOR. Price $137.50†. See him now for details and literature or write RCA, Commercial Engineering, Section K 19W, Harrison, N. J.

Radio Corporation of America
Components Division **Camden, N. J.**

Check these outstanding features:

• wide-vision open-face extra-large (7½") meter scale • mirror-strip on scale to eliminate needle-to-scale parallax • two-color, separate scales for speedy peak-to-peak and rms voltage readings • work-simplifying single probe with built-in switch for all Ohms and DC/AC Voltage measurements • high stability circuit free from effects of line voltage variations • meter tracking error only ±1% or less • accuracy of ±3% full scale on all AC and DC ranges • DC current readings as low as 10 μa.

ELECTRICAL SPECIFICATIONS			
Operation	Ranges	Input R, C	Freq. Response
DC Volts	0 to 1500 (7 ranges) Low Scale, 0 to 1.5	*11 meg., 2 μμf	
AC Volts (RMS, sine waves)	0 to 1500 (7 ranges) Low Scale, 0 to 1.5	0.83 to 1.5 meg. 75 μμf to 85 μμf	30 cps to 3 Mc** (for source impedance of 100 ohms)
AC Volts (Peak-to-Peak values, sine or complex wave forms)	0 to 4200 (7 ranges) Low Scale, 0 to 4		
Direct-Current	0 to 15 a. (9 ranges) Low Scale, 0 to 500 μa		
Ohms	0 to 1000 megohms (7 ranges)		
MECHANICAL SPECIFICATIONS Height: 10"; Width: 13½"; Depth: 7"; Weight: 8 lbs.			

*1100 meg. with WG-289 Probe and WG-206 Multiplier Resistor.
**Crystal-Diode Probe WG-301A available to extend range to 50 Kc to 250 Mc within ±10%.
†User price (optional) Complete with WG-299C DC/AC Ohms Probe, Low-Capacitance Flexible Cable, Current Leads, Ground Lead, Instructions.

miniature

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pulse transformers

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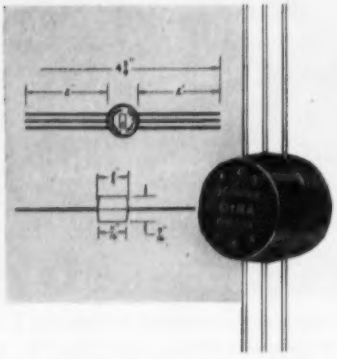
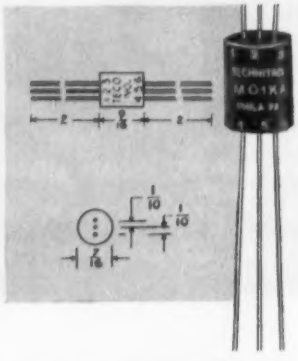
Type MILX... for extreme environmental conditions



Type M... for subminiature and transistor circuits



Technitrol is equipped to design and produce pulse transformers to meet your particular requirements. Simply let us know your performance specifications. Technitrol's staff of engineers will test sample transformers under actual circuit conditions—assuring proper performance. All charges for this service are included in our low sample quantity price.

Technitrol also makes a full line of lumped and distributed parameter Delay Lines. You may choose from a variety of mountings, or again, our engineers will aid you in developing special designs.

for additional information, write for Bulletin E166.

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engineering company

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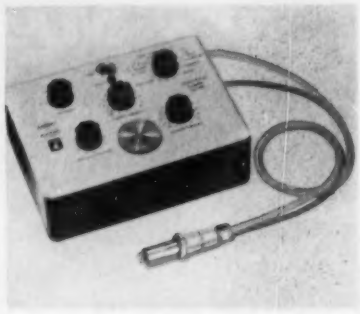
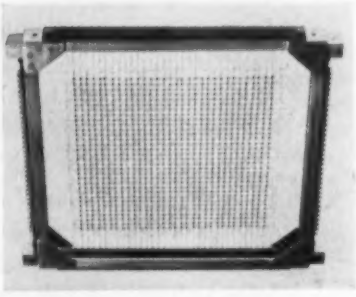


pickup and one of the AF analyzers models BL-2105, BL-2109, or amplifier models BL-2601 or BL-2602. Thus, users are provided with absolute measurement or recording of acceleration, velocity or displacement.

▶ **Functions**—A 2-stage preamplifier with high input impedance allows vibration measurements to be carried out to very low frequencies at extended distances from the measuring instrument. A built-in calibration unit, consisting of a vibrating disk suspended on a metal strip which is brought into resonance at the line frequency, affords a direct and quick calibration of the combination of accelerometer, preamplifier and measuring instrument before the measurements are carried out.

A set of integrating networks is provided for measurements of the velocity and displacement of the vibrations in consideration. **Circle P46 inside back cover.**



MEMORY CORE PLANES
standard and special sizes

GENERAL CERAMICS CORP., Keasbey, N. J., has produced new magnetic memory core planes. Standard type 1 memory frames have the conventional wiring scheme of one x, one y, and one z, and one sense

An UNKNOWN WORLD Awaits Us, Too

TERRA INCOGNITA – the Unknown World. This was the challenge to men of earlier centuries . . . to venture into the mysterious, unexplored regions of the Earth. They met the challenge and found new lands.

While no continents or uncharted seas remain for us to discover, an unknown world awaits us too. The challenge to men of our times is to venture still farther into the unexplored realms of scientific knowledge. Today's scientists are opening new worlds as truly as did Magellan and Columbus. Helping them speed their discoveries are the men who design and build Remington Rand Univac® electronic computing systems. Univac recognizes the importance of the contributions of their engineers and technicians in this new age of discovery. They are important men . . . and Univac treats them accordingly.

IMMEDIATE OPENINGS FOR:

ELECTRONIC CIRCUIT DESIGNERS — To utilize such new circuit elements as transistors and magnetic amplifiers in high speed digital computing circuits. E.E. degree or equivalent experience required. Pulse circuit techniques, particularly such as are acquired in radar, telemetering, guided missiles or TV will satisfy many of our requirements.

MAGNETIC CORE MEMORY — For memory core and general magnetic testing projects. Degree in E.E. or equivalent plus circuitry experience. To be responsible for program.

LOGICAL DESIGNERS — Experience in logical design of digital computers.

MECHANICAL ENGINEERS (ELECTRO) — Development of computer input-output devices and servo-mechanisms. Research and development work in the field of small, high speed, electrically-actuated mechanisms where ultra reliability is a must.

PHYSICISTS — For research and development of new circuits.

CHEMISTS — Inorganic or physical. Minimum of 5 years experience.

TECHNICAL PUBLICATION ENGINEERS — Engineers with background in circuitry mathematics or symbolic logic with writing experience.

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ENGINEERS & PHYSICISTS

Electronics

APL-An Organization Of And For Technical Men And Scientists

The Applied Physics Laboratory (APL) of the Johns Hopkins University is an organization of and for technical men and scientists. Several factors allow for more effective utilization of "mind power" at APL. They lead to tangible and intangible satisfactions for staff members that could not be gained elsewhere.

Among them are:

1. Individual staff members are given a measure of responsibility and initiative much greater than in many comparable establishments. Decision-making, on all levels, is placed in the hands of scientists and technical men.

2. Staff members do not restrict their efforts to limited technical problems. Instead they are asked to assess and solve problems of a systems nature, including analyses of complete tactical problems.

3. APL handles technical direction of the work of many associate and sub contractors, including 21 universities and leading industrial organizations. As a result, APL staff members enjoy a rewarding exchange of ideas and techniques with other leaders in R & D.

4. The combined facilities of APL, its associate and sub contractors, and Government test stations provide opportunities for members of its technical staff to develop and exploit their varied capabilities in a unique environment where teamwork and individual initiative are fused.

5. This esprit and freedom to look into new concepts has resulted in a number of "quantum jumps" in defense capability, including the proximity fuze, the first supersonic ramjet engine, and the Navy's Bumblebee family of missiles which includes TERRIER, TALOS and TARTAR. APL is presently attempting breakthroughs on several important fronts.

APL'S expansion program recently witnessed the completion of new laboratories covering 350,000 sq. ft. in Howard County, Maryland, equidistant from Washington, D. C. and Baltimore. Men of originality are invited to inquire about staff opportunities. Salaries compare favorably with those of other R & D organizations.

OPENINGS EXIST IN:

ANALYSIS: Dynamic analysis of closed-loop control systems; analysis and synthesis of guidance systems; counter-countermeasures systems; electrical noise and interference.

DESIGN: Control and guidance circuitry; telemetering and data-processing equipment; microwave components, antennas, and radomes; transistor and magamp applications; external missile systems.

TEST: Prototype engineering and field test evaluation.

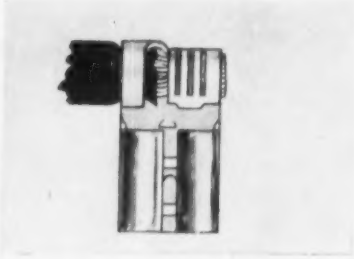
For Additional information write: Professional Staff Appointments

The Johns Hopkins University Applied Physics Laboratory

8609 GEORGIA AVENUE, SILVER SPRING, MD.

winding through each core. Standard frame sizes are 10 cores by 10 cores, 16 cores by 16 cores, 32 cores by 32 cores and 64 cores by 64 cores. The wire frames are available, using either the Ferramic S-1 or the Ferramic S-3 memory core.

In addition to the above standard sizes of memory frames, facilities are available for the design and production of frames of different wiring patterns and different sizes. **Circle P47 inside back cover.**



FLAG-TYPE TERMINALS
with insulation support

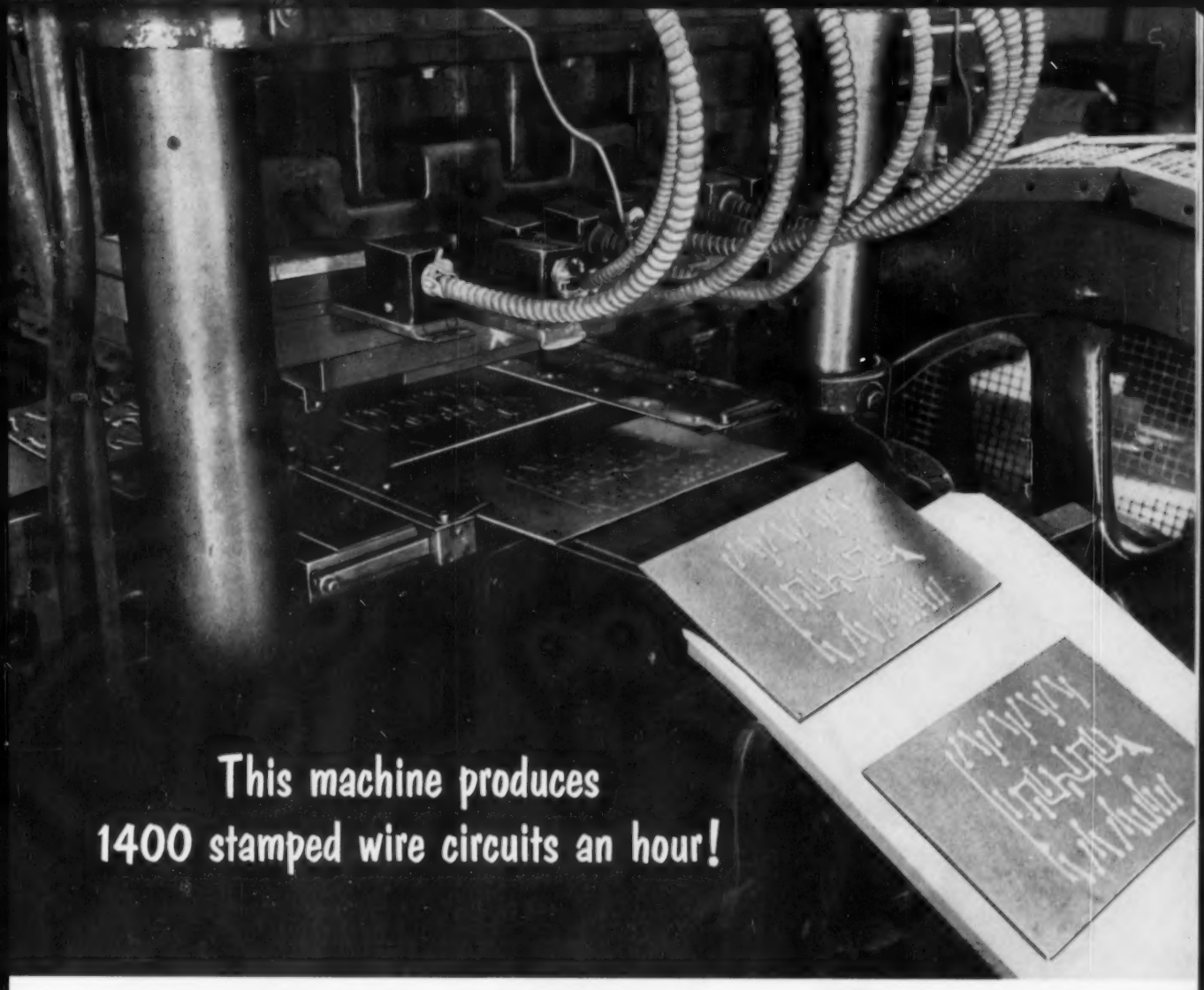
AIRCRAFT-MARINE PRODUCTS, INC., Harrisburg, Pa., announces a new line of Junior Faston flag-type terminal with insulation support. The flag-type feature makes the terminals handy to apply in unusual position applications, and their insulation support absorbs wire vibration and adds strength to the connection. They accommodate wire sizes 22-14.

Junior Fastons in the straight-on insulated and noninsulated support types accommodating wire sizes 22-14 are also available. Further information and literature may be had on request. **Circle P48 inside back cover.**

PULSE GENERATOR
features high output

ELECTRO-PULSE, INC., 11861 Teale St., Culver City, Calif. Model 2125A pulse generator provides an economical source of fast rise time pulses for a wide range of laboratory and test applications. High output, consistent with good waveform, is available through optional use of an internal load resistor. Controls provide excellent resolution, utilizing multiple decade

new members of the



WITH EACH STROKE A COMPLETE STAMPED CIRCUIT EMERGES READY FOR USE IN RADIO–TELEVISION–AUTOMOBILE DASH BOARDS–ELECTRONIC CIRCUITS

FABRICATORS OF INSULATED PARTS should check new patent #2,753,519 issued July 1956. You can now fabricate insulated parts with metal pieces attached. Save hand assembly of metal contacts—connectors—ground straps, etc. Little space or equipment is necessary . . . only a standard press equipped with an automatic device for feeding the copper and insulated material.

The scrap is automatically reclaimed.

PRODUCE 2,000,000 RADIO RECEIVERS, as one manufacturer did in less time and at lower production cost . . . "tooling cost also nominal . . . can be made on engraving machine."

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LICENSE AVAILABLE ON NOMINAL ROYALTY BASIS!

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Stamped wiring is fully covered in the following patents:

U. S. Patents		
#2,401,472	2,535,674	2,679,596
2,431,393	2,622,054	2,753,619
2,431,725	2,647,852	

Foreign Patents		
#62,605	Argentina	610,058 Gt. Britain
129,783	Australia	741,241 Gt. Britain
353,181	Canada	918,687 France
		420,575 Italy

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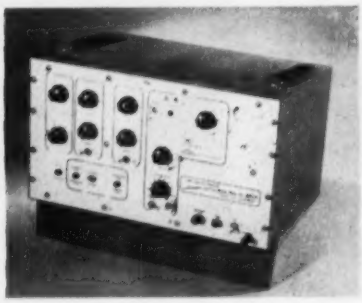

ranges for pulse spacing, delay and width.

Repetition rates from 10 cps to 100 kc, variable advance or delay operation from 0 to 100 μsec, variable pulse width from 0.1 μsec to 100 μsec, and a variable amplitude low impedance output characterize the new instrument. **Circle P49 inside back cover.**

SEALED ROTARY POT covers 100 to 50,000 ohms

GLENDALE CONTROLS CO., Glendale, Calif. The PRM123 is a rotary type, 1⅛ in. diameter, single gang only, bushing mounted, sleeve bearing potentiometer. Standard tolerances are ±3 percent in resistance, and ±0.3 percent on independent linearity. Operating temperatures for standard models are −65 F to 275 F. Rotation is 360 deg mechanical (continuous). Standard electrical angle is 350 deg ±2 deg.

All models of the rotary trim potentiometer can be quickly furnished with explosion-proof or dust-tight seals. Special models are also available on order. The PRM123 is designed to meet military specifications MIL-R-12934 and MIL-

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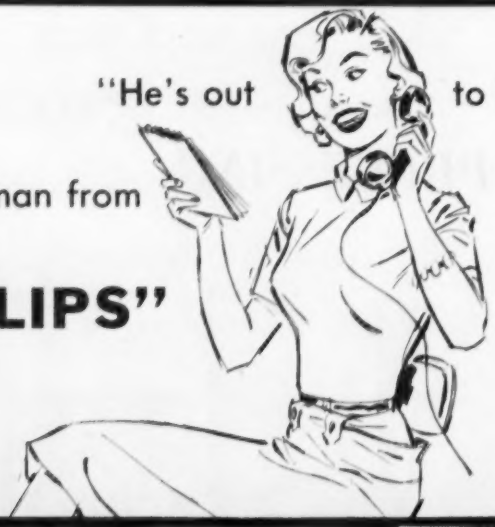
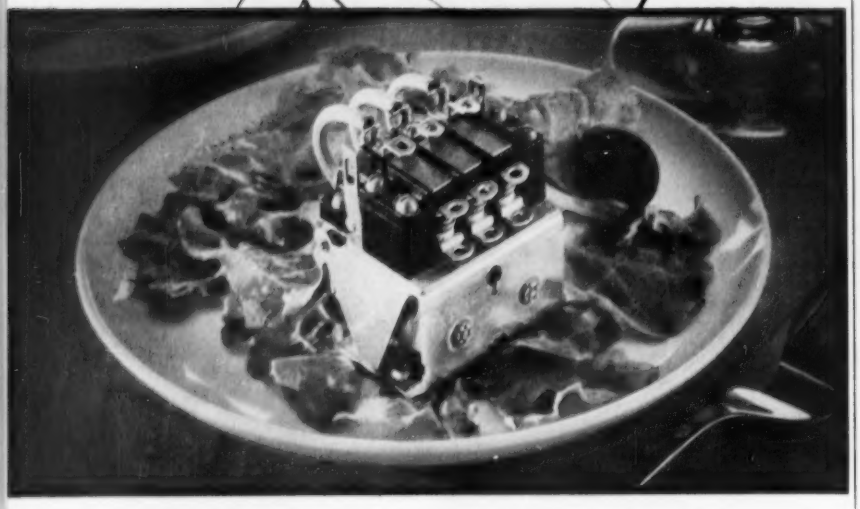
"He's out to lunch with the man from PHILLIPS"





is this your dish? Compact and efficient, this Type 27 power relay is designed for maximum reliability and long life. The armature is supported by stainless steel pins in two bronze bushings and the frame is held rigidly by brass side plates. Its stationary contacts are mounted on molded phenolic with integral barriers and the movable contacts on precision tempered blades. All movable blades are preset with locked adjusting screws. The restoring spring force is adjustable for accurate setting of pick-up and drop-out. The two-coil design of Type 27 power relay coupled with its efficient magnetic circuit provides high sensitivity.

But whether your dish is a power-type relay, AC or DC, or a multi-contact telephone type relay — you should call the "man with the PHILLIPS Plan".

COIL CHARACTERISTICS:
Operating Voltage:
up to 230 volts D.C.
Resistance: up to 13400 ohms
Operating Current:
.005 amps., minimum

CONTACT ASSEMBLY
1, 2, 3, 4 or 5 pole
Single or double throw
Contacts: Standard:
10 amps. non-inductive
Heavy Duty: 20 amps. non-inductive
Special Heavy Duty:
25 amps. non-inductive

MOUNTING:
Four No. 6-32
tapped holes — standard

VARIATIONS:
Plug-in mounting and terminals
Enclosures with
solder or screw terminals
Hermetically sealed assemblies
Mechanical latching assemblies

Phil-trol

HERMETIC SEALS, MULTI-CONTACT, POWER, HERMETICALLY SEALED RELAYS, ACTUATORS

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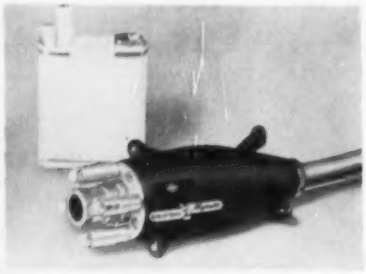
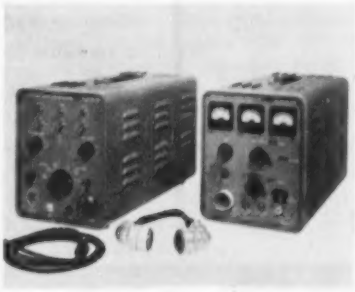
E-5272. **Circle P50 inside back cover.**



MINIATURE TV CAMERA
a remote-controlled unit

MAJESTIC INTERNATIONAL CORP., 743 North LaSalle St., Chicago 10, Ill. A cigar-shaped television camera, called the Peepsqueek, is designed for industrial, scientific and medical tv viewing. The camera is less than 6 in. long, measuring only 1⅞ in. in diameter. Its size and the fact that it is equipped with spring-loaded guide rollers permit thorough inside inspection of previously inaccessible areas such as pipes, tubing and walls.

This remote-controlled unit contains a mini-resistron and a number of subminiature tubes that serve as amplifying elements. A conical mirror accessory may be mounted ⅜ in. ahead of the lens combination to reflect the image of the inside walls. The image received can be magnified up to 20 times since the focal length of the lens system is only ½ in. **Circle P51 inside back cover.**



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THE W. L. MAXSON CORP., 47-37 Austell Place, Long Island City 1, N. Y. Substantial r-f power output

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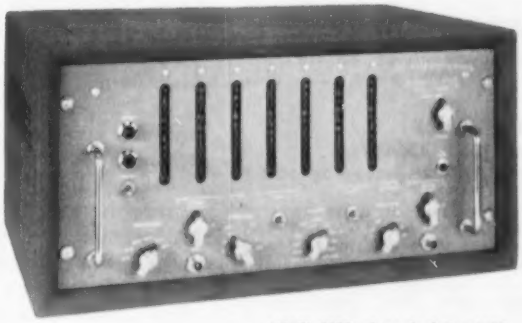
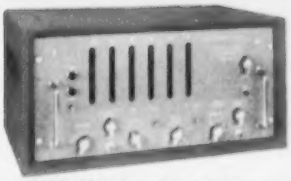
MODELS
7350 and 7360

UNIVERSAL EPUT* & TIMERS



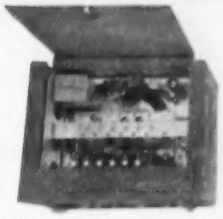
MODEL 7360 – 0 cps to 1 mc range



MODEL 7350 – 0 cps to 100 kc range

MODEL 5916 IN-LINE REMOTE READOUT offers large illuminated in-line figures all on one plane which can be read from any angle. Reduces error and fatigue; ideal for remote observation of data.

MODEL 1452 DIGITAL PRINTER prints data on standard adding machine tape. 7000-Series instruments also drive data converters to operate card punches or electric typewriters.



Accessibility is an important feature of BERKELEY 7000-Series instruments. Modular chassis design permits rapid checking or replacement of components and sub-assemblies.

DESCRIPTION

These truly universal instruments combine high-speed electronic counting with a precision time base in multi-purpose circuitry. They function as counters, timers, time-interval meters, EPUT* meters, frequency, frequency ratio or period meters, or as secondary frequency standards. No other single instruments yet devised offers their wide range of usefulness in the laboratory or test stand.

All models have provision for standardization against WWV and may be coupled to external frequency standards. Connections are provided for driving Berkeley digital printers, data converters, or in-line remote readout units.

FEATURES

1. *0.1 v rms sensitivity*
2. *Step attenuators; trigger-adjusted noise discriminators*
3. *More stable frequency dividers*
4. *Electronic (not relay) reset*
5. *External frequency standard input connection*
6. *AC or DC coupling of all input circuits; 10 megohm input impedance*
7. *Multivoltage accessory socket to power photocells, etc.*
8. *Binary-coded output with direct connection to digital printers, data converters, inline readouts, etc.*
9. *Crystal-controlled time marker output*
10. *Unitized modular design*
11. *Larger, brighter readout numbers*
12. *Modern-styled all-aluminum cabinets*

BRIEF SPECIFICATIONS

	Model 7350	Model 7360
Ranges—Frequency:	0 cps to 100 kc	0 cps to 1 mc
Time Interval:	10 μ sec to 10^{6} sec	1 μ sec to 10^{7} sec
Period:	0 cps to 100 kc	0 cps to 1 mc
Time Bases:	10μ sec to 10 sec	1 μ sec to 10 sec
Accuracy:	± 1 count, ± crystal stability	
Crystal Stability:	± 3 parts in 10^{6} per week	± 3 parts in 10^{7} per week
Input Requirements:	0.1 v rms, 10 megohm impedance, dc or ac – coupled	
Display Time:	Adjustable, 0.1 to 5 seconds (automatic reset). Manual reset also provided.	
Dimensions:	10¼"H x 20¾"W x 16½"D (cabinet mount; rack mount available)	
Price: (f.o.b. factory)	$890.00	$1,175.00

Technical bulletins and application data files are yours for the asking; please address Department G 11

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WILEY — BOOKS

1) CIRCUIT THEORY AND DESIGN

By JOHN L. STEWART, California Institute of Technology

An important new book which applies modern network theory to the understanding of vacuum tubes and feedback systems. It stresses pole-zero design methods, founded on an easily grasped pictorial representation, and includes careful treatment of many topics which are especially useful adjuncts to circuit design. 1956. 480 pages. 463 illus. $9.50.

2) RADIO TELEMETRY

SECOND EDITION

By MYRON H. NICHOLS, Ramo-Wooldridge Corporation and LAWRENCE L. RAUCH, University of Michigan

Here, for the first time in a single volume, is all the material on radio telemetry. This valuable book provides complete coverage of theory, methods, and techniques, as well as analysis of telemetry practice and equipment. 1956. 461 pages. 206 illus. $12.00.

3) PRINCIPLES OF COLOR TELEVISION

By The HAZELTINE LABORATORIES STAFF Compiled and edited by Knox McIlwain and Charles E. Dean

Helps you make the transition from monochrome to color TV thinking and solve the problems you will encounter in practice. Exclusive features include: engineering design of receivers, a full chapter on gamma, FCC specifications, glossary of color TV terms. 1956. 595 pages. 252 illus. $13.00.

4) VACUUM TUBE CIRCUITS AND TRANSISTORS

By LAWRENCE B. ARGUIMBAU, with transistor contributions by RICHARD B. ADLER, M.I.T.

An extension of Arguimbau's earlier well-known work on vacuum tube circuits, this new book contains up-to-date material on transistors, color television, frequency modulation, and noise. 1956. 646 pages. 652 illus. $10.25.

5) PHOTOCONDUCTIVITY CONFERENCE

Edited by R. G. BRECKENRIDGE, National Carbon Co., B. R. RUSSELL, The College of Wooster, and the late E. E. HAHN. With 46 contributors.

Thorough coverage of the subject of photoconductivity. Stresses basic theory, phenomenological theory, interpretation of photoconduction phenomena, and the most recent data on the properties of important photoconducting materials. 1956. 653 pages. 216 illus. $13.50.

6) ELECTRONIC TRANSFORMERS AND CIRCUITS

SECOND EDITION

By REUBEN LEE, Westinghouse Electric Corporation

Simple, practical and thoroughly up to date. Contains the most useful information on the design of transformers for electronic equipment and the effects of transformer characteristics on electronic circuits. 1955. 360 pages. 263 illus. $7.50.

7) PRINCIPLES OF NUMERICAL ANALYSIS

By ZDENEK KOPAL, University of Manchester, England

A lucid presentation of those parts of analysis and algebra on which numerical methods are based. Applications in such areas as the use of large-scale computing machines for automatic work are fully emphasized. 1955. 568 pages. Illus. $12.00.

8) THE VACUUM DEPOSITION and PROPERTIES of THIN FILMS

By L. HOLLAND, W. Edwards & Co., London

This work covers in detail: plant design, film production, and the physical properties of thin films for all purposes. 1956. 541 pages. Illus. $10.00.

9) TECHNICAL PUBLICATIONS

Their Purpose, Preparation and Production

By C. BAKER, A.R.Ae.S.

A sure guide to the preparation and production of technical literature. 1955. 302 pages. Illus. $6.25.

10) AUTOMATIC DIGITAL COMPUTERS

By DR. M. V. WILKES, Cambridge University

Written by a man who helped in the development of EDSAC, this book provides valuable material on history, design, principles of programming, and operation. 1956. 305 pages. $7.00.

11) HIGH VACUUM TECHNIQUE

THIRD EDITION

By J. YARWOOD, The London Polytechnic

Theory, practice, industrial applications and properties of materials. 1955. 208 pages. Illus. $5.50.

12) ABSTRACTS OF THE LITERATURE ON SEMICONDUCTING and LUMINESCENT MATERIALS and THEIR APPLICATIONS

1954 ISSUE

Compiled by the Batelle Memorial Institute and sponsored by The Electrochemical Society. 1955. 200 pages. Spiral Binding. $5.00.

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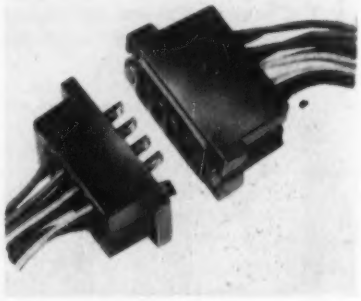
through a broad band of high frequencies characterizes the model 1141 power oscillator.

▶ **Specifications** — Output exceeds 40 w, from 200 to 400 mc; 25 w from 400 to 1,000 mc; and 10 w, from 1,000 to 2,500 mc. Frequency range is covered in two overlapping bands: 200 to 1,050 and 950 to 2,500 mc. Calibration accuracy is ± 1 percent or ±5 mc, whichever is greater; resettability is better than 0.1 percent.

The oscillator is equipped for square-wave or sine-wave modulation from built-in 400-cycle and 1,000 cycle sources. Provision is also made to allow modulation at other frequencies from a suitable external source. Modulation level and r-f output level are adjustable over wide ranges.

The instrument comprises an oscillator unit and a power supply modulator unit, each contained in a well ventilated metal case 11½ in. by 9½ in. by 20½ in. Circle P52 inside back cover.



PLUG AND RECEPTACLE
feature crimped terminals

MOLEX PRODUCTS CO., 9515 Southview Ave., Brookfield, Ill., has announced a new low-cost plug and receptacle featuring fast, simple assembly for use in applications requiring multiple circuit hookups. Crimped terminals for snap-in assembly eliminate time consuming soldering and cut assembly costs by as much as 75 percent.

Terminals are available individually or in reels for automatic machine assembly to wires. They are rated up to 15 amperes per terminal; are molded from a U. L. approved Molex compound which

New Allen-Bradley developments

GREATER COLOR PURITY—BETTER CONVERGENCE

1. FULL ROUND YOKE CORES

FOR COLOR TV

ALSO BLACK AND WHITE

Allen-Bradley has developed a method of producing ferrite deflection yoke cores as a full 360° ring! Unlike cores made from quarter rounds, the new full round cores are perfectly concentric and have parallel inner surfaces. They require no grinding. The round rings are "cracked" into halves and taped for shipment. Assembly is quick and economical. The tape is rolled back, the core is slipped over the coils, and the tape put back in place. The core's concentricity assures better convergence and greater color purity.

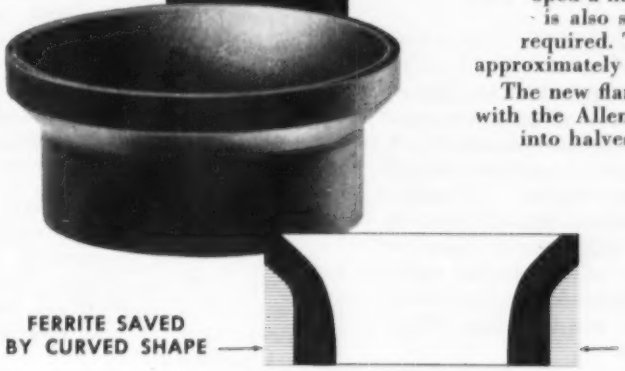
These ferrite yoke cores are produced as full rounds, and are "cracked" into halves and taped, as shown, for easy assembly.

2. FLARED YOKE FERRITE CORES

FOR NEW 110° TUBE . . . SAVES WEIGHT

For the new 110° picture tube, Allen-Bradley has developed a flared yoke ferrite core whose outer surface is also shaped to reduce the amount of material required. This makes possible a weight reduction of approximately 30% over conventional cylindrical cores.

The new flared yoke is produced as a solid piece but, with the Allen-Bradley method, the yoke is "cracked" into halves, yet a perfect ring is maintained. Available in Allen-Bradley Class WO-1 ferrites which are to be preferred because of their uniform magnetic characteristics.



Allen-Bradley Co.
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In Canada—
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A-B Quality

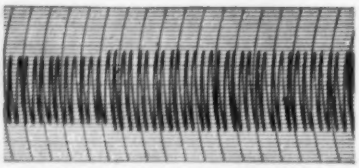
ALLEN-BRADLEY

RADIO, ELECTRONIC, AND TELEVISION COMPONENTS

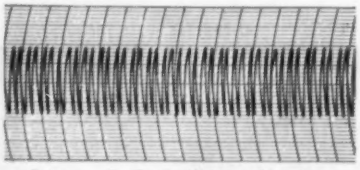
QUALITY

Want more information? Use post card on last page.

Regulation in *less than 1/50th cycle...*



Output of typical electromechanical regulator in response to step change in input voltage. Average correction rate of 6v. per sec.



Output of Curtiss-Wright Distortion Eliminating Voltage Regulator from same input. Full recovery in 330 microsec.

Simultaneous two-pen recording of 60 c.p.s. voltage

PLUS Pure Sine Wave Power

CURTISS-WRIGHT LINE REGULATOR

- **Electronically regulates r.m.s. and peak voltage simultaneously to ±1%.**
- **Reduces typical power line distortion to less than 0.3%.**
- **Furnishes 1.4 KVA of distortion-free power.**
- **Introduces no phase shift between input and output.**
- **Simultaneously provides additional 4 KVA of ±1% electromechanically regulated power.**

Faster recovery time (less than 1/60th cycle, or 330 microseconds) plus the unique ability to *eliminate* line distortion — these are the reasons why the Curtiss-Wright Distortion Eliminating Voltage Regulator has been chosen by more and more laboratories and production test departments. Besides general laboratory use, this line regulator provides simpler, more accurate calibration of meters . . . better design of transformers, synchros, motors . . . easier testing of such components, with fewer rejects . . . easier, more accurate measurement of magnetic properties and receiver sensitivity . . . better a.c. computer performance . . . elimination of fast line transient effects. Write for details.

Electronic Component & Instrument Sales Department

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • CARLSTADT, N. J.

provides good electrical and physical properties, plus dimensional stability and low moisture absorption. Additional information is available. **Circle P53 inside back cover.**

WIRE-WOUND POT
direct-mounting type

GEORGE-HELD, INC., 1020 North LaBrea, Los Angeles 38, Calif. The PC-5 wire-wound potentiometer mounts directly on the printed circuit board by its own round leads. It eliminates the use of screws and lugs now required for mounting conventional potentiometers.

The environmental resistant construction, light weight, small size (¼ in. diameter, ¾ in. height), suit the PC-5 to airborne and other compact equipment. The cylindrical shape is easily adaptable to automatic installation techniques.

► **Features**—Terminal linearity is ±3 percent; resistance range, 10 to 35,000 ohms; dissipation, 2 w; rotation 325 deg. It also features noncorrosive, nonnutrient, sealed construction. **Circle P54 inside back cover.**

TOTALIZING COUNTERS
feature long life

ANATRAN CORP., 165 E. California St., Pasadena, Calif. The new Digicon and Digipot are designed for use with remote indication and control shaft position, telemeter-

Progress in the Science of Measurement

Doelcam

MAGNETIK NULL INDICATOR

"Today's Version of the D-C Galvanometer"

"The D-C Galvanometer was essential to the historial experiments in electricity conducted by men like Galvani, Ampére and Lord Kelvin. However, the dense stray fields of today's electrical world combined with the need for greater speed and accuracy in the laboratory and on the production line place a heavier burden on the present day galvanometer. The Doelcam Magnetik Null Indicator, Model 2HG-1 is today's most practical version of the D-C Galvanometer. Not only does it combine magnetic and electronic elements which make it insensitive to stray pickup; but it has 3 discreet ranges, linear scale for deflection measurements fast response and the ability to withstand overloads as high as 100,000 times full scale deflection."

Write for Bulletin NI-7

PERFORMANCE CHARACTERISTICS

ISOLATED INPUT: Input terminals are isolated from chassis and circuit ground.

HIGH SENSITIVITY: 2 Microvolts per division, 0.003 Microamperes per division.

HIGH CONVERTER FREQUENCY: 2500 cps carrier, insensitive to 60 or 120 cps pickup.

LOW NOISE LEVEL: Less than 2 Microvolts equivalent input.

EXCELLENT STABILITY: Zero drift less than 1 division per hour.

INDEPENDENT OF LINE VOLTAGE: No observable drift or change in sensitivity for line variations from 105 to 125 volts.

PROPORTIONAL DEFLECTIONS: Linearity over full scale range is 5%.

POLARITY SENSITIVE: Zero-center mirror-scale meter for polarity sensing measurements.

QUICK READING: Time constant of less than 1 second.

RUGGED: Not damaged by over-range of 45 volts d-c.

LOW MAINTENANCE: Only one vacuum tube. No moving parts except meter.

Doelcam

A DIVISION OF MINNEAPOLIS-HONEYWELL

H HONEYWELL

1400 SOLDIERS FIELD ROAD
BOSTON 35, MASSACHUSETTS

Instruments for Measurement and Control

Synchros • Gyros • Accelerometers • Amplifiers • Microsyns • Servo Motors

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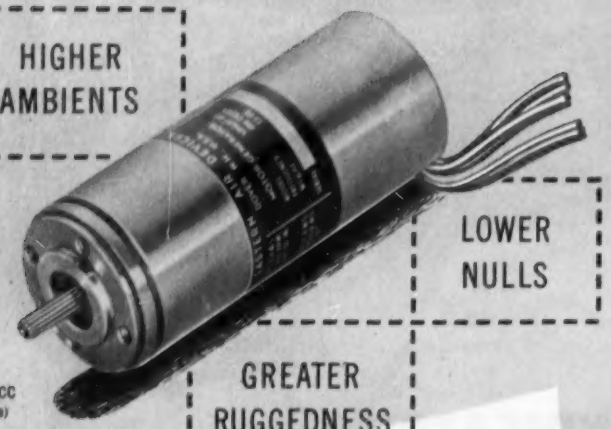
EAD announces an unusually precise

SERVOMOTOR-TACHOMETER GENERATOR

HIGHER AMBIENTS

LOWER NULLS

GREATER RUGGEDNESS



SIZE 11
SJ1HLX7-1CC
(Actual size)

for
INSTRUMENTATION
FIRE CONTROL
AUTOPILOTS
MISSILES
COMPUTERS

FEATURES:

Zero Speed Voltage (RMS) 3.0 mv in phase, 10.0 mv quadrature, 13.0 mv total

Ambient temp. 150°C

Linearity 0.5% @3600 rpm

Servo meets Bu. Ord. MK-14 specifications.

Equipped with precision gearhead for EXACT output speed.

Rugged, one-piece assembly.

WRITE for complete detailed information

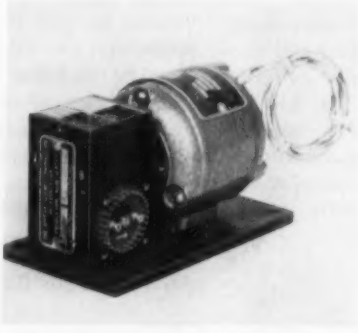
EASTERN AIR DEVICES, INC.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD

387 CENTRAL AVENUE • DOVER, NEW HAMPSHIRE

ing by radio link, direct readout to card punching equipment, remote control of communications equipment and as components of analog and digital servo systems. They are designed with 10 contacts or a potentiometer coupled to each visual indicator wheel.

▶ **Specifications** — Counters are rated for continuous duty at 1,000 rpm or 2,000 rpm intermittent duty. Life without maintenance exceeds 50 million counts. Additional features are the small size —1¾ in. and 2¾ in. for 3 and 5 digit units respectively; lighted number wheels, high speed operation from either step or shaft rotation inputs and extreme stability under adverse environmental conditions. Complete specifications are given in bulletin 802-230. **Circle P55 inside back cover.**



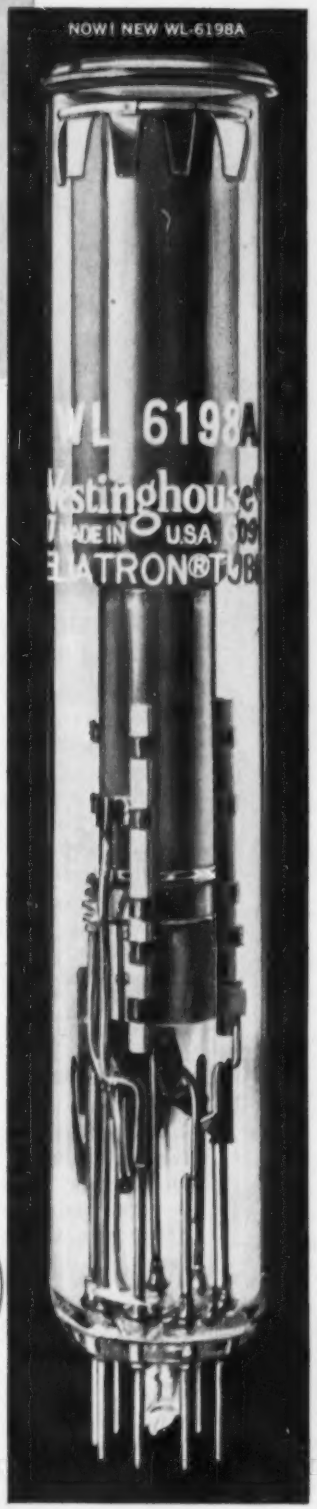
SAMPLING SWITCH
multichannel type

APPLIED SCIENCE CORP. OF PRINCETON, P. O. Box 44, Princeton, N. J. The new Ascop type AA switch features 2 poles with 24, 30 or 32 contacts per pole and sampling

CURRENT WL-6198

TOP VIEW

The side appendage will no longer be necessary thanks to advanced Westinghouse design.



TOP VIEW

New orientation markings on the 6198A permit use of the full photo surface area.

NEW AND IMPROVED DESIGN FROM WESTINGHOUSE

Westinghouse first with redesigned Type 6198 Vidicon Camera Pick-Up Tube . . . first to bring you these important improvements!

IMPROVED MECHANICAL DESIGN. Since the side appendage has been deleted, yoke construction can be greatly simplified because a slot does not have to be provided.

IMPROVED ELECTRICAL DESIGN. This advanced new design permits use of full-length deflection coils in the yoke, and provides focus uniformity to materially improve picture shading. Further, the new WL-6198A permits the introduction of a more uniform photo-sensitive surface to reduce the mottling effects in the picture.

IMPROVED PERFORMANCE FEATURES. Now that mottling is reduced and picture shading improved, the resultant picture is of more uniform clarity . . . with a truer image . . . closer by far to the actual subject being observed and transmitted by the camera.

ENGINEERS! For challenge, security, growth potential, investigate career opportunities now being offered by Westinghouse Electronic Tube Division. Write Technical Placement Director, Westinghouse Electric Corp., Electronic Tube Division, Elmira, N. Y.

You will want full details on this new Westinghouse Vidicon Camera Pick-Up Tube. Get detailed technical data by writing to Commercial Engineering Dept., Westinghouse Electric Corp., Elmira, N. Y.

WATCH WESTINGHOUSE

*WHERE **BIG** THINGS ARE HAPPENING FOR **YOU!***

6ET-4118

Want more information? Use post card on last page.

Epsco
Model VR-607

NEW
ULTRA-STABLE
Secondary-standard
Voltage-reference Source

▸ 0.01% absolute accuracy*

▸ 1-millivolt steps
any voltage selectable from +111.112 to −111.112 volts

▸ 1-microvolt resolution
with 10-microvolt steps when used with 100:1 precision attenuator

Engineering data sheet on request.

This versatile easy-to-use instrument is valuable as:

- a secondary standard for precision voltage measurements
- a meter and transducer calibrator
- an absolute reference source for analog computers
- a standard reference* for use with Epsco's DATRAC® and ADDAVERTER voltage-to-digital conversion equipment
- a low-impedance precision attenuator

SPECIFICATIONS

Size: 11¼x15¼x16½" (portable model). Rack-mounting unit occupies 14" height. *Weight:* 50 lbs. *Power input:* 150 watts, 95-125 volts, 50-65 cycles single-phase.

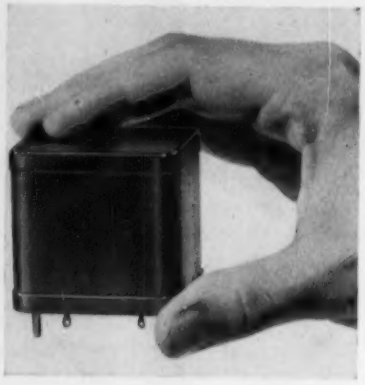
*Originally designed to meet the precision requirements of Epsco's DATRAC® and ADDAVERTER.

Epsco incorporated

588 COMMONWEALTH AVE., BOSTON 15, MASSACHUSETTS Tel: COpley 7-8100

rates up to 6 rps. Special construction allows manual phasing of both poles through 360 deg. Both poles may be manually phased during operation.

The switch will operate efficiently up to 175 F and under a wide range of shock and vibration conditions. It weighs only 26 oz including the 115-v 60-cycle motor. **Circle P56 inside back cover.**



POWER SUPPLIES
small and light in weight

ARNOLD MAGNETICS CO., 5962 Smiley Drive, Culver City, Calif., has available switching transistor power supplies that convert low voltage d-c to higher voltage d-c or a-c. They are hermetically sealed, very small and light in weight, handling 120 w per lb. There are no contacts or moving parts—units contain only transistors, toroids and ½-w resistors. Hence maintenance is eliminated.

Switching does not stop when the unit is momentarily overloaded because the switching signal is a function of the instantaneous load current.

The power supplies are designed for such applications as missile and aircraft, portable battery-powered equipment and high-power uses. **Circle P57 inside back cover.**

TRANSMITTER RACKS
heavy duty type

PREMIER METAL PRODUCTS CO., 337 Manida St., New York 59, N. Y., is manufacturing a new line of heavy duty transmitter racks de-

case history No. 5 of JFD Piston Capacitors at work

PISTON CAPACITORS AT WORK

You're a jet fighter pilot streaking home to your carrier 200 miles distant . . . somewhere in the dead of night . . . above a pea-soup fog. No margin for error here . . . minutes, yards mean the difference between success and failure. Yet you're guided unerringly every second of the flight. Safely . . . swiftly you let down to home base—thanks to *TACAN* (Tactical Air Navigation).

Federal Telecommunication Laboratories specified the Model VC11 *JFD Variable Trimmer Piston Capacitors* in its *TACAN* development program for the U. S. Navy and U. S. Air Force. Used in the Ferris discriminator circuit of the IF amplifier, the VC11 is used in adjusting critical band pass frequencies to prevent adjacent channel interference. Compactness . . . stability . . . shock-resistance . . . imperviousness to temperature variations . . . — these are a few of the reasons why today Federal Telephone and Radio Co., Hoffman Laboratories, Inc., and Stromberg-Carlson Co. (A Division of General Dynamics Corporation), are building JFD VC11 Capacitors into *TACAN* equipment.

The VC11 is one of 50 miniature and subminiature trimmer capacitors upgrading performance in today's most sensitive printed and conventional electronic circuits. Wouldn't you like to see how they can help you on *your* project?

MODEL VC11
Approx. zero temperature coefficient, 1 to 10 mmf., fused quartz dielectric, invar rotor

JFD ELECTRONICS CORPORATION
1462—62 STREET BROOKLYN, N. Y.

Go Forward with JFD Engineering!

NEW - Air-transportable Control Tower

Flight demonstration at Fort Devens, Mass. of ***Helicop-Hut*** *Air Traffic Control Set.*

HELICOP-HUT* AIR TRAFFIC CONTROL SET

Requires only 30 minutes to set up for operation.

A highly mobile two-man unit designed for directing and controlling airport traffic; for Civil Defense and weather reporting purposes.

SELF-CONTAINED (except for primary power), includes communications equipment, weather instruments, console, equipment racks, storage facilities, electrical and ventilating systems, miscellaneous equipment.

TRANSPORTABLE by helicopter, cargo aircraft, truck, or special carriage.

LIGHTWEIGHT — 2500 pounds complete with electronic equipment.

COMPACT — 96" long, 76" wide, 54" high; 75" from floor to ceiling of observation dome.

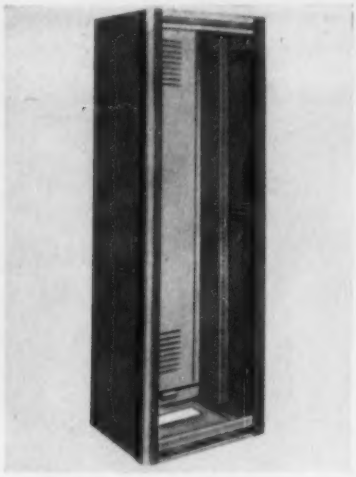
SHELTER CONSTRUCTION—New process—aluminum skins bonded to a plastic foam core give high strength/weight ratio.

For further information, write or phone —

Craig SYSTEMS, INC. *TRADE MARK

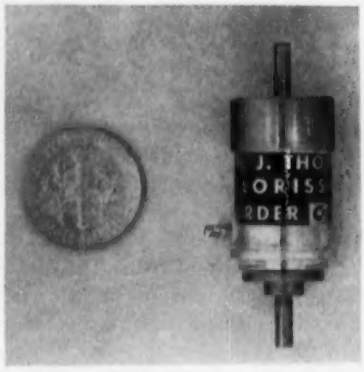
Dept. B-11 — Danvers, Mass. Phone: Danvers 1870

Craig also supplies other types of control towers, complete mobile electronic systems and various types of shelters, vans and trailers.



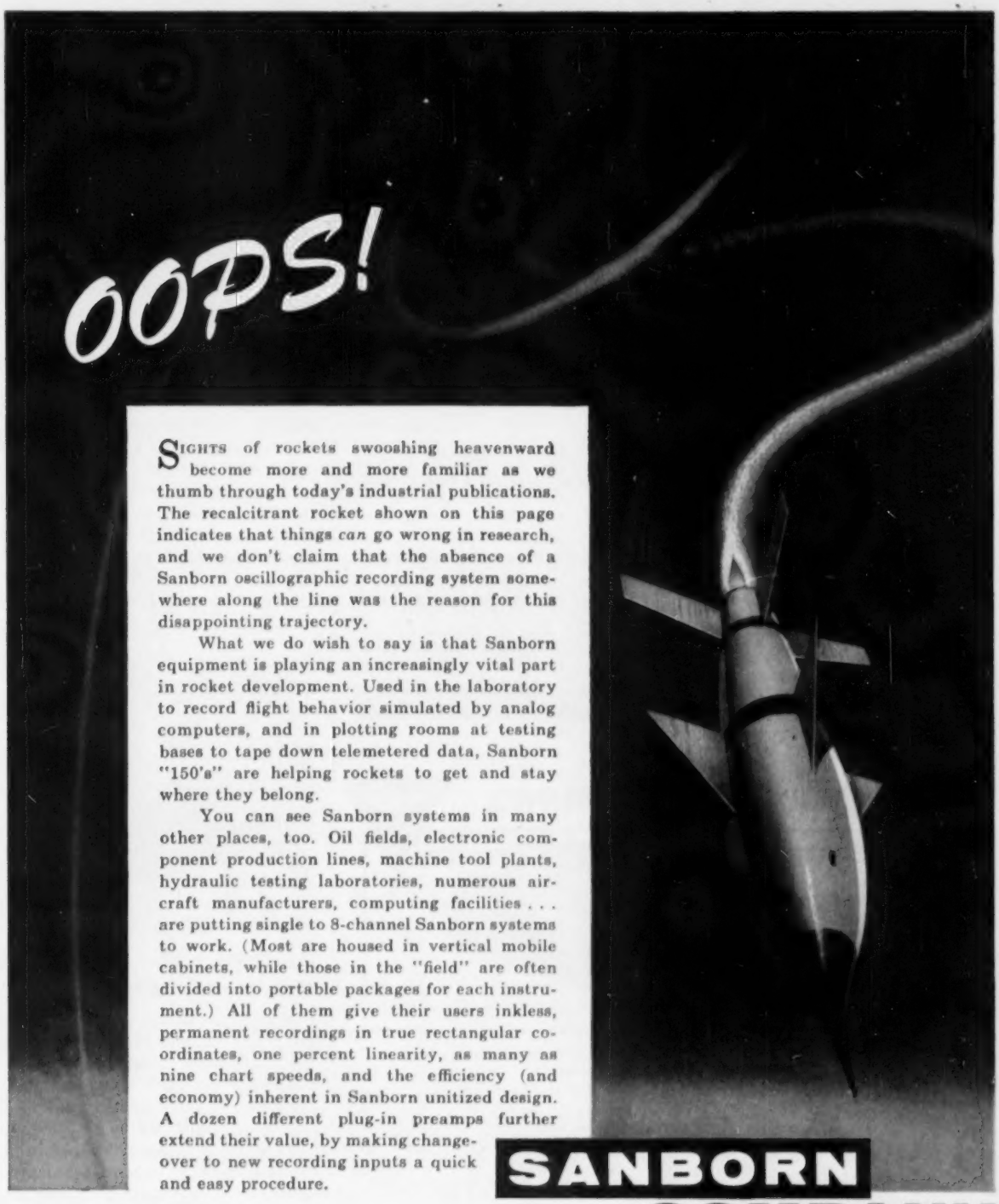
signed to accommodate 24 in. rack panels. The racks are 27 in. wide by 24 in. deep and are available in 8 sizes, with or without front doors. They feature adjustable panel mounting angles $\frac{3}{16}$ thick and tapped 12-24 on universal spacings; rectangular cut-out in bottom for leads, duplex receptacle and outlet box in back.

Constructed of 16 gage steel with a 12 gage bottom and welded throughout, the racks have rear doors closed by a chrome handle, red striped chrome moulding top and bottom. They are supplied with or without louvres. **Circle P58 inside back cover.**



ELECTROMAGNETIC CLUTCHES
three new miniature units

A. J. THOMPSON, INC., Route 1, Box 812, Florissant, Mo., has available a new line of miniature electromagnetic clutches for electronic and instrument applications. The C line couples the input hub to



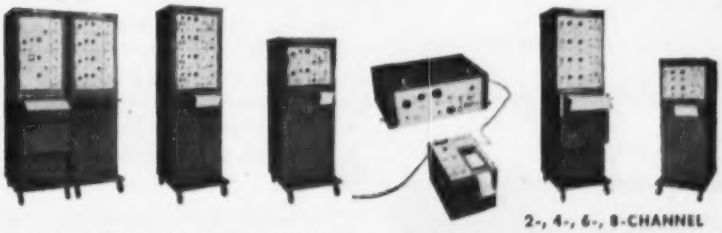
SIGHTS of rockets swooshing heavenward become more and more familiar as we thumb through today's industrial publications. The recalcitrant rocket shown on this page indicates that things *can* go wrong in research, and we don't claim that the absence of a Sanborn oscillographic recording system somewhere along the line was the reason for this disappointing trajectory.

What we do wish to say is that Sanborn equipment is playing an increasingly vital part in rocket development. Used in the laboratory to record flight behavior simulated by analog computers, and in plotting rooms at testing bases to tape down telemetered data, Sanborn "150's" are helping rockets to get and stay where they belong.

You can see Sanborn systems in many other places, too. Oil fields, electronic component production lines, machine tool plants, hydraulic testing laboratories, numerous aircraft manufacturers, computing facilities . . . are putting single to 8-channel Sanborn systems to work. (Most are housed in vertical mobile cabinets, while those in the "field" are often divided into portable packages for each instrument.) All of them give their users inkless, permanent recordings in true rectangular coordinates, one percent linearity, as many as nine chart speeds, and the efficiency (and economy) inherent in Sanborn unitized design. A dozen different plug-in preamps further extend their value, by making changeover to new recording inputs a quick and easy procedure.

SANBORN COMPANY

CAMBRIDGE 39, MASSACHUSETTS

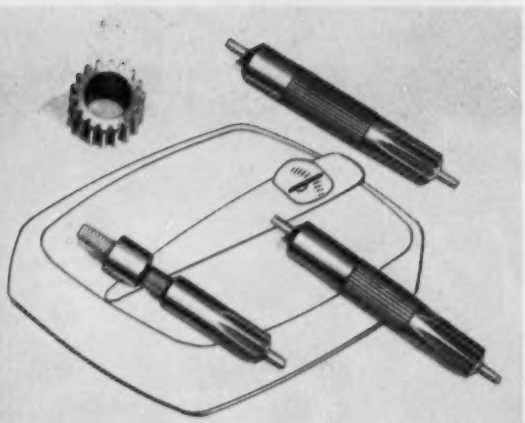


8-, 6-CHANNEL 4-CHANNEL 2-CHANNEL 1-CHANNEL 2-, 4-, 6-, 8-CHANNEL ANALOG COMPUTER SYSTEMS

Which way rockets are going may not be a primary concern of yours. But if recording problems are, you're apt to find some interesting and useful answers in Sanborn's 16 page "150 System" catalog. Write to us for a copy.

Want more information? Use post card on last page.

20
TO
200 D.P.
SEND YOUR PRINTS FOR QUOTATION



SPURS • HELICALS • WORM AND WORM GEARS • STRAIGHT BEVELS
LEAD SCREWS • RATCHETS • CLUSTER GEARS • RACKS • INTERNALS • ODD SHAPES

THE *Finest* IN GEARS
Beaver Gear Works Inc.
1021 PARMELE STREET, ROCKFORD, ILLINOIS

ULTRA
WIDE-BAND AMPLIFIER
1Kc
210 Mc

20db GAIN

- Extended low frequency response to 1000 cps
- High frequency response to 210 Mc with linear phase shift and rise time less than .0026 μ sec
- Gain flat to within $\pm 1\frac{1}{2}$ db and stabilized to ± 0.2 db
- Voltage and current regulation minimize effect of fluctuations in line voltage and tube characteristics
- Ideal for distortionless pulse and transient amplification as in radar, nuclear and television research

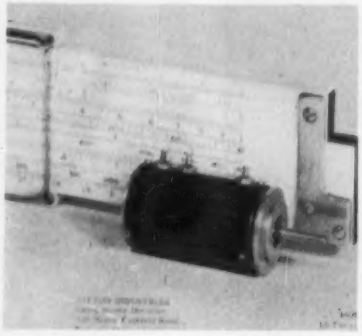
Write for data sheet on SKL Model 202D

SKL SPENCER-KENNEDY LABORATORIES, INC.
1320 SOLDIERS FIELD ROAD, BOSTON 35, MASS.

the output shaft when energized; both the hub and output shaft being free when deenergized.

They are ideal for airborne applications. The servo mounted units are available with output shaft at either or both ends. Controlled torque output under vibration meets requirements of MIL-E-5272A. Units operate on d-c voltage.

►**Technical Data** — Performance specifications of the C-4 model are 0.59 in. in diameter by 0.93 in. long (excluding input and output shafts), weighing 0.8 oz and transmitting 4 in. oz of torque. Model C-6 is 0.83 in. in diameter by 1.34 in. long (excluding shafts) weighing 2.3 oz and transmits 16 in. oz of torque. Model C-10 is 1.37 in. in diameter by 1.765 in. long and transmits 60 in. oz of torque. **Circle P59 inside back cover.**

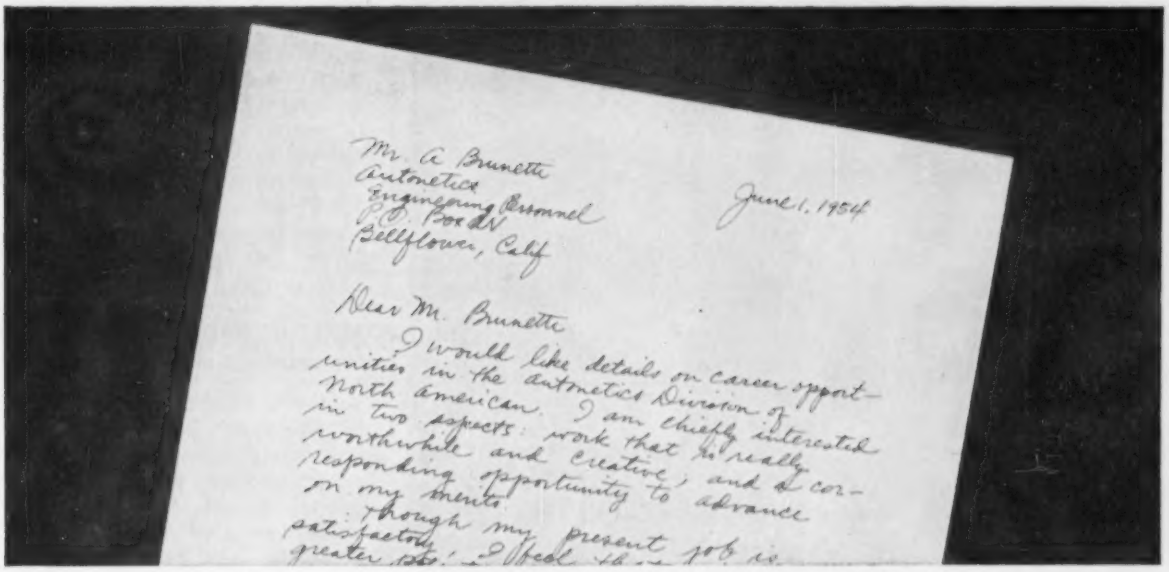


TEN-TURN POT
is ⅞ in. in diameter

LITTON INDUSTRIES, 5873 Rodeo Road, Los Angeles 16, Calif. Model LA09 10-turn potentiometer is especially designed to meet critical demands for reliability in military electronics equipment.

The ⅞ in. diameter potentiometer is built with a rugged all-metal external construction, sturdy metal-to-metal stops, precision stainless steel ball bearings, and glass-sealed terminals positively seated to the metal housing to provide mechanical reliability and a low leakage path. Terminals are gold-plated for excellent solderability.

►**Technical Data**—Resolution as close as 0.008 percent is the re-


Mr. A Brunetti
Autonetics
Engineering Personnel
P.O. Box AN
Bellflower, Calif
June 1, 1954
Dear Mr. Brunetti
I would like details on career opportunities in the Autonetics Division of North American. I am chiefly interested in two aspects: work that is really worthwhile and creative; and a corresponding opportunity to advance on my merits.
Though my present

This letter moved a man ahead 5 years

Two years ago a man took 10 minutes to write this letter. Today he enjoys the responsibility and professional standing in the AUTONETICS Division of North American that might have taken 7 to 10 years to achieve in other fields.

THE FIELD AT AUTONETICS—A FIELD OF OPPORTUNITY

Now under way at AUTONETICS are nearly 100 projects, comprising some of the most advanced and progressive work being done today in the fields of Electronics, Electro-Mechanics, Control Engineering and Data Processing.

You will work on automatic control systems of many kinds, for manned and unmanned vehicles. Every state of the art is represented, from preliminary conception right through flight testing. Facilities are the finest obtainable. Your colleagues will be men of ability and imagination, of the highest professional standing.

The long-range potential in this field is truly limitless. The techniques being developed at AUTONETICS today will have the widest application in the industrial methods of tomorrow.

You owe it to yourself to consider how far you can advance by entering this exceptionally promising field right now. Here are the opportunities:

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Write your letter today. Decide now to get the facts, so you can make the most of your potential. Just put your address and brief qualifications on paper—handwritten will be fine. Reply will be prompt, factual, confidential.

Write: Mr. A. Brunetti, Autonetics Engineering Personnel,
Dept. 991-11E, P. O. Box AN, Bellflower, California

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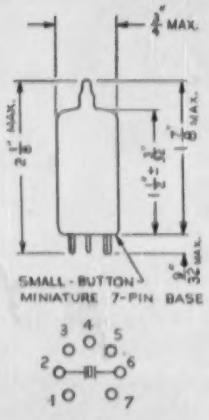
A DIVISION OF NORTH AMERICAN AVIATION, INC.

AUTOMATIC CONTROLS MAN HAS NEVER BUILT BEFORE

ACTUAL SIZE OF NEW BLILEY BG6A

A NEW CRYSTAL UNIT WITH *PLUS* FEATURES FOR PRECISION APPLICATIONS IN RANGE 3 mc TO 100 mc.



This all-glass vacuum mounted crystal unit offers *high reliability for applications which require minimum ageing*. When used with drive level less than one milliwatt, frequency shift due to ageing will not exceed .0002% during the first year of service.

Supplied for oven or non-oven operation. Specify Bliley type BG6A.

WRITE FOR TECHNICAL BULLETIN #496

Bliley CRYSTALS

BLILEY ELECTRIC COMPANY
UNION STATION BUILDING
ERIE, PA.

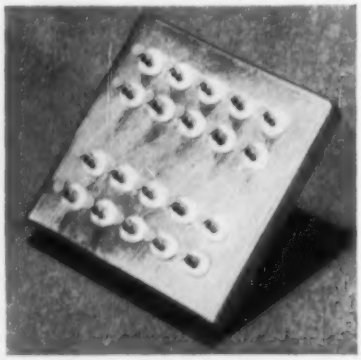
sult of winding a large number of turns of resistance wire on a mandrel 17 percent longer than in previously available potentiometers. Linearity is held as close as 0.05 percent. All connections are welded. Taps are welded to a single turn of resistance wire. **Circle P60 inside back cover.**

MARINE RADAR
for small vessels

KELVIN & HUGHES (MARINE) LTD., 99 Fenchurch St., London, England, has designed type 14 marine radar for use on fishing and small coastal vessels. A slotted waveguide radiator scanner unit eliminates the conventional reflector. Extensive use has been made of printed circuitry and components potted in resin. Magnetic techniques have eliminated use of thermionic tubes in the transmitter. Price of the radar is $3,350.

The unit has a 9-in. tube with preset electrostatic focusing, and has 5 range scales up to 48 miles. There are separate monitoring facilities for transmitter and display unit.

A motor generator for use on a number of voltage ranges and a-c or d-c ships mains has also been produced. It has avc and needs no starter unit. **Circle P61 inside back cover.**



PRESS-FIT TERMINALS
for closer spacings

SEALECTRO CORP., 610 Fayette Ave., Mamaroneck, N. Y. With dielectric strength ranging from 1,000 to 2,000 v per mil thickness, these

SIMPLYTROL AUTOMATIC PYROMETERS

For Control of Temperature

10 standard ranges from −200° to +3000° F.

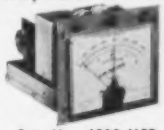
Accuracy 2% (limit of calibration error).

Sensitivity 4 ohms per millivolt.

Cat. No. 4535, size 10" x 6" x 7". Range 0/1000°F, 0/500°C. **$135.00**

Thermocouple-type automatic pyrometer for controlling temperature in furnaces or ovens and manufacturing processes. Leads between Simplytrol and its thermocouple sensing element may be up to 100 feet or more depending on temperature range and lead wire resistance. Load relay, 5 amperes S.P.D.T. Optional heavy duty relays to 40 A. Either AUTOMATIC control or LIMIT shutoff. An automatic Simplytrol turns heat on and off to hold required temperature. Proportioning effect can be increased or decreased by changing cam on the sensing cycle. With shorter cycles, control more nearly approaches straight line. A limit Simplytrol locks up when the trip point is reached and remains locked until reset. Use limit Simplytrols for monitoring and safety shutoff or alarm.

Cabinet model for wall mounting or portable shown above. To the right is an MFP Simplytrol for flush mounting in a cabinet or control panel. Several other mountings are shown in Catalog 4-A. Send for your copy. **Assembly Products, Inc., Chesterland 4, Ohio.** Phone (Cleveland, O.) HAmilton 3-4436. (West Coast: Desert Hot Springs 4, Calif. Phone 4-3133 or 4-2453).



Cat. No. 4532-MFP, size 5" x 5½" x 8" deep. Range 0/1500°F, 0/800°C. **$127.00**

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MODEL FL-4A

for manufacturers and users of high-speed tape recorders, who are engaged in instrumentation, telemetering and data transmission systems.

Features:

- Measures flutter frequencies dc to 5000 cps
- Internal 24 db/octave filters for analysis
- 3" oscilloscope for detailed flutter studies

Specifications:

Carrier frequency: 14.5kc from crystal oscillator
Indicators: ±2% drift and rms flutter meters
Range: 0.2, 0.6, and 2.0% rms full scale
Flutter filters: 0.5 to 30 cps; 30 to 300 cps; 300 to 5000 cps
Dimensions: 8¾"x 19" standard rack

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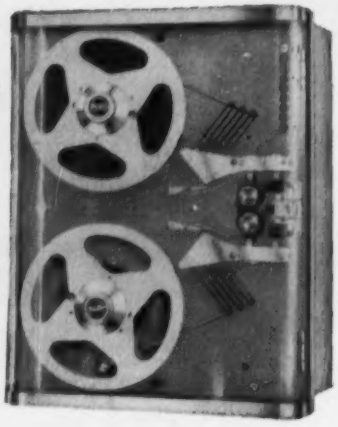
3 MSEC STARTS AND STOPS



Model 905 Digital Magnetic Tape Handler

The Ultimate in Digital Tape Handlers for High-Speed Computers, Electronic Business Machines, Industrial Control and Other EDP Applications.

Regardless of cost, many features are exclusive with Potter

Speed and ease of operation—Up to 75"/sec in a variety of dual speed combinations, with 3 msec starts and stops. Tape widths from ¼" to 1 ¼" are accommodated. Automatic threading, fast rewind, end-of-tape sensing, and front panel or remote control provide unmatched flexibility and ease of operation.

Standard 19" Rack Mounting—Hinged front panel provides quick access to mechanical parts and plug-in electronic components. Transparent dust cover protects tape and moving parts without hindering visual observation of tape track.

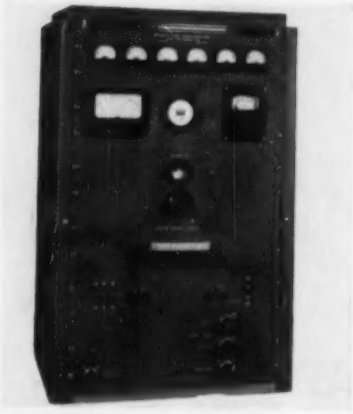
Auxiliary Equipment—A complete line of digital data-handling accessories is available, including *record-playback heads* (Model 6400) in numerous channel number and tape width combinations. *Record-playback amplifiers* can be furnished as individual plug-in units (Models 52, 53) or in *complete systems* (Model 920) for return-to-zero or non-return-to-zero recording. *Shift registers, high speed printers and other data-handling components* are available separately or in integrated systems for solving specific data-processing problems.

WRITE FOR INFORMATIVE BULLETIN . . . and feel free to consult Potter engineers on your data-handling problems. No obligation, of course.

POTTER INSTRUMENT COMPANY, INC.
115 Cutter Mill Road Great Neck, L. I., N. Y.

Teflon Press-Fit terminals open up new design possibilities by way of still closer spaced terminals, such as in canned transformers, precision potentiometers and coil assemblies. Typical is an encased transformer top with two banks of ten terminals each, with Press-Fit terminals spaced only ¼ in. between centers. Each feed-through terminal has turret lugs for inside and outside wrap-around and soldered connections.

The terminals are now available in eight RETMA color-code colors—white, brown, yellow, blue, red, orange, green and gray. Available in both stand-off and feed-through designs, in miniature and subminiature sizes, Press-Fit terminals are readily installed by press-fitting into the proper sized hole, using the insertion tool in a drill-press type equipment. **Circle P62 inside back cover.**



TWT POWER SUPPLY
regulated to 0.005 percent

LAWN ELECTRONICS CO., INC., East Freehold Road, Freehold, N. J. Model 5550 traveling-wave-tube power supply provides 2,000 to 5,500 positive or negative volts at 500 ma.

▶ **Features**—The supply is regulated to 0.005 percent and ripple voltage is less than 25 mv. The output voltage can be modulated through its complete range by a few volts of external modulation. Extreme stability is obtained by using a chopper amplifier to correct the drift of the d-c amplifier. **Circle P6 inside back cover.**

New Literature

Beryllium Copper Alloy. The Beryllium Corp., Reading, Pa. A 4-page bulletin describes the physical properties which make this alloy particularly suited for applications in the electrical and electronic fields—including these design factors: (1) high electrical conductivity; (2) service temperatures of 400 F and above; (3) excellent spring characteristics; and (4) corrosion resistance.

The bulletin gives information on applications of Berylco 10 strip for such design uses as: current carrying springs, circuit breaker parts, clips and the like. Charts, tables and graphs give complete data on properties, composition and tempers available. **Circle L1 inside back cover.**

Printed Circuit Connectors. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A 12-page technical brochure describes an expanded line of printed circuit receptacles, designed for $\frac{1}{16}$ in., $\frac{1}{8}$ in. and $\frac{1}{4}$ in. printed circuit boards. Included in the series discussed are types with 6, 10, 15, 18, 22 and 28 contacts in single or dual rows to accommodate up to 56 connections.

An outstanding feature of the connectors described is the "bellows action" contact for extra durability and reduction in board tolerance problems. Gold-plated phosphor bronze spring retains tension, allows use of undersized or oversized board while maintaining low contact resistance of less than 20 mv at 5 amperes.

Molding compounds for the units described include mineral filled Melamine and Plaskon reinforced (glass) Alkyd type 440A. Wiring styles are eyelet lug, solderless wire wrap, taper tab solderless wiring, and contacts for dip soldering. **Circle L2 inside back cover.**

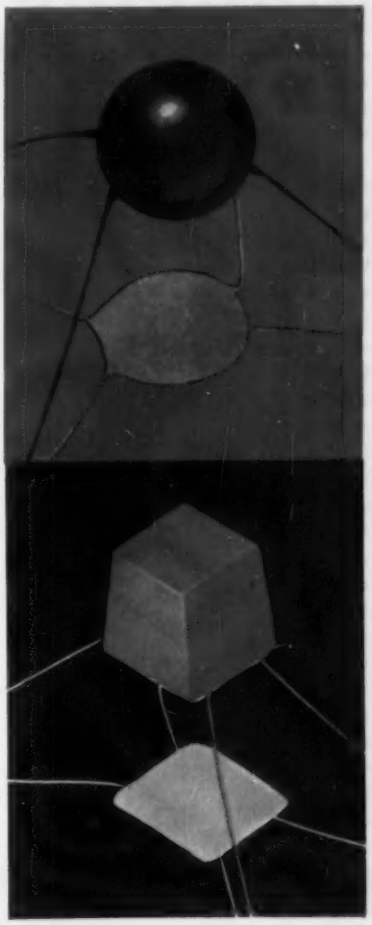
Carrier Amplifier. Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif. Bulletin 1550 B covers the type 1-127 four-channel 20-kc carrier amplifier system which offers linear frequency response from 0 to 3,000 cps. Included are information on applications, features, sensitivity, high-speed recording and a list of specifications. **Circle L3 inside back cover.**

Magnetic Industrial Counters. Berkeley Division of Beckman Instruments, Inc., 2200 Wright Ave., Richmond, Calif. Theory and circuitry underlying substitution of magnetic devices for vacuum tubes in industrial high speed counting equipment is explained in the new data file 109. It explains how the Ferristor, a miniature saturable reactor device, replaces most of the short-lived vacuum tubes to produce a far more rugged and reliable events-per-unit-time instrument for countless industrial uses.

Besides describing the Ferristor itself, the data file includes a detailed study of circuitry, time base and other electronic components involved in designing the magnetic EPUT. Complete diagrams illustrate the text. **Circle L4 inside back cover.**

Thermistor Overheat Detectors. Fenwal Inc., Ashland, Mass. Bulletin MC-134 describes a new line of thermistor overheat detectors for aviation service. It discusses the advantages of thermistor elements for temperature detection which include stability and compactness and permit leads up to 200 ft long and relatively simple circuitry. Present and potential applications are depicted. Physical and performance specifications are listed. **Circle L5 inside back cover.**

Threshold Indicator. Stoddard Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif., has available literature describing the new 91296-1 threshold indicator. The unit discussed is a signal actuated go-no-go accessory which may be used with r-i/f-i meters (covering frequencies from 30 cps to 1,000 mc) to operate a bell, lamp or other alarm system when radio interference exceeds the limit of military specifications, such as MIL-I-6181B, proposed



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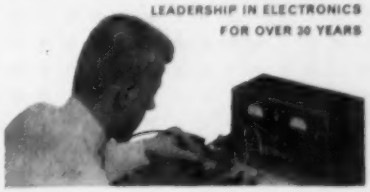

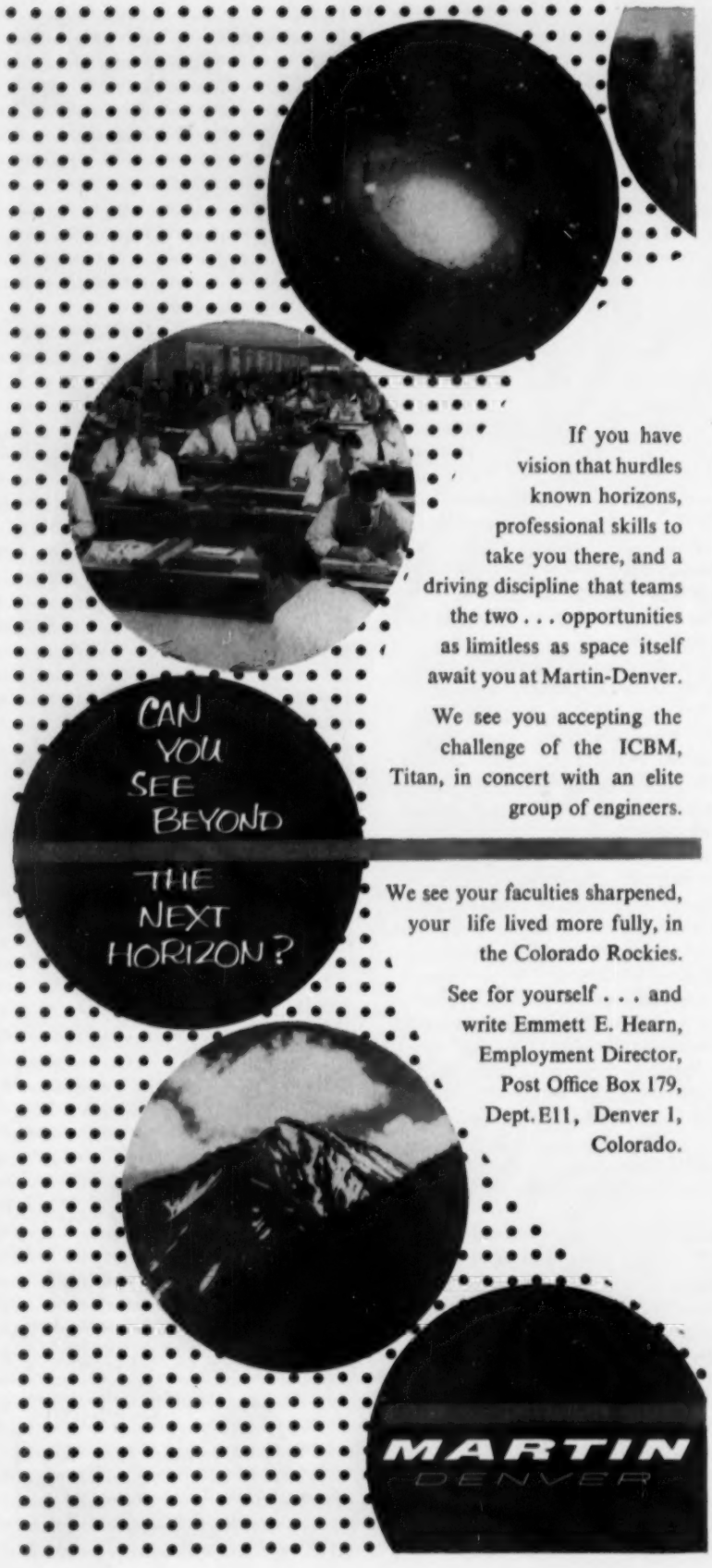
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MIL-I-6181C, MIL-I-16910A, proposed MIL-I-16910B, MIL-I-11683A, MIL-I-001683B, and MIL-S-10379A.

Illustration, descriptive text and specifications are provided, as well as brief descriptions, with photos, of the r-i/f-i measuring units with which the threshold indicator may be used. **Circle L6 inside back cover.**

Bantam Speed Reducers. Metro Instrument Co., 432 Lincoln St., Denver 3, Colorado. Bulletin No. 98 describes the company's small but powerful Bantam speed reducers. The reducers illustrated in the bulletin have a maximum power output of 0.1 h-p at the low speed shaft. Standard units and units with an antibacklash feature are described. Each kind is available in over 400 fixed ratios. Many electronic applications are listed. **Circle L7 inside back cover.**

Single-Turn Potentiometer. Helipot Corp., Newport Beach, Calif. The 2-in. diameter series 5600 precision potentiometer is the subject of data sheet 54-49. A single-turn, continuous-rotation unit for servo or bushing mounting, the series described offers high resolution and close linearity characteristics.

Data sheet 54-49 is illustrated and lists specifications, construction, coil characteristics and available modifications. **Circle L8 inside back cover.**

Mica Data File. Mycalex Corp. of America, 125 Clifton Blvd., Clifton, N. J. A completely revised engineering data file, containing technical information, design considerations and suggested applications of the company's Supramica ceramoplastic and Mycalex glass-bonded mica products has been issued. Illustrated 4-page sections on Supramica 500 and 555 ceramoplastics, Mycalex 400 and 410 glass-bonded mica, as well as a comparison chart detailing the properties of these materials and other plastic and ceramic insulators of comparable use are assembled in a file folder for inclusion in engineering files and libraries. Additional sections of the data file provide information on special Mycalex glass-bonded mica for-

mulations for capacitor dielectrics and other specific applications, and machining and fabricating instructions for working the materials.

Charts of electrical and thermal characteristics and complete tubular data on the physical properties of the materials are included. The file will be kept up-to-date with additional material on new developments. **Circle L9 inside back cover.**

Flowmeter. Industrial Development Laboratories, Inc., 17 Pollock Ave., Jersey City 5, N. J. A new catalog describes function, construction and operation of the Laub Electro-Caloric flowmeter. The 4-page, 2-color catalog lists the advantages of the instrument.

A cutaway view clearly illustrates the construction of the smooth-bore flow cell while a simple diagram effectively shows the principles of operation. Standard sizes and materials are listed and complete mechanical and electrical specifications are furnished. **Circle L10 inside back cover.**

One-Third Octave Filter Set. Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio, has released a single-page catalog sheet, illustrating and describing the one-third octave filter set, model BL-1609. The instrument described is specially designed for sound and vibration analysis, measurement of sound transmission and reverberation time, and in general, any audio signal analysis or telemetry data reduction.

The free literature contains detailed design, operating and installation information which suggests various application opportunities. One side of the sheet covers detailed specifications of the instrument. **Circle L11 inside back cover.**

Thermistors. General Electric Co., Detroit 32, Mich., has announced a newly revised 53-page manual on thermistors, thermally sensitive resistors for automatic detection, measurement and control of physical energy.

The publication, designated TH-13A, describes the latest general, material and operating characteristics of the electronic semiconduc-

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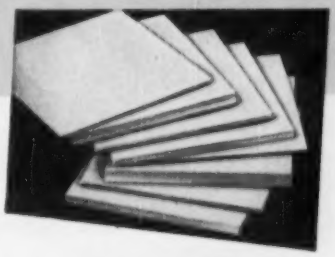

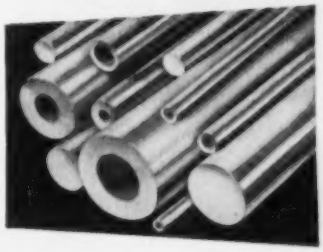

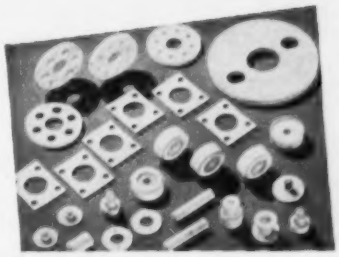

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tors, as well as general types of applications. Besides basic data, it also includes details on thermistor assemblies, static and dynamic characteristic curves in addition to user information on how to order them. **Circle L12 inside back cover.**

VHF Communications Receiver. Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y. A 2-page brochure TDS 5200, lists specifications for a professional quality a-m and f-m receiver covering the frequency of 50 to 200 mc in one continuous band. The receiver described is used in the laboratory to calibrate other receivers; in flight-testing; control tower, propagation studies; monitoring; evaluating transmitters; meteor research; and as a general, all-round communications receiver.

Full specifications are listed in the brochure. **Circle L13 inside back cover.**

Automatic Direction Finder. Aircraft Radio Corp., Boonton, N. J., has available a 4-page brochure describing its new automatic direction finder system, the type 21ADF. The system described—receiver, power unit, control unit, loop, and indicator—weighs less than 20 lb and is designed for use on all types of aircraft, especially where weight, size, operating reliability, and minimum air drag are important considerations.

The 2-color brochure lists specifications and provides illustrations of its loop housing installation. **Circle L14 inside back cover.**

Millivoltage Measurement Instruments. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. Concise information about Speedomax H electronic potentiometer-type indicators, recorders and controllers calibrated directly in millivolts— −5 to 0 to + 5 mv, 0 to 10 mv, or 0 to 50 mv—is now available in an illustrated 2-page data sheet.

This sheet completely lists features and specifications of the Speedomax H indicators and recorders, and presents a condensed tabulation of instrument charac-

teristics for control applications ranging from simple two-position to full-proportioning control. **Circle L15 inside back cover.**

Resistor Catalog. Cinema Engineering Div. of Aerovox Corp., 1100 Chestnut St., Burbank, Calif. Bulletin No. LC-1030BX is a 20-page booklet dealing with the entire Cinema line of wire wound, fixed, accurate encapsulated resistors. The catalog, issued yearly, includes a military specification tabulation for the first time.

Cinema resistors include the CE100 and CE200 series, radial wire terminals or radial lug terminals; the PW100 and PW200 series, for printed circuitry, axial wire terminals or radial lug terminals.

Information includes line drawings of the products, as well as descriptive tabulations. **Circle L16 inside back cover.**

Tubing Metals and Alloys. Superior Tube Co., 1528 Germantown Ave., Norristown, Pa. Data Memorandum No. 1 lists 121 metals and alloys from which the firm produces its standard and special small diameter tubing. The analyses are conveniently grouped into carbon, alloy and stainless steels, nickel and nickel alloys, copper and copper base alloys, glass sealing alloys, reactive metals (titanium and zirconium) and nickel cathode materials. They are also grouped as to whether standard or special analyses.

The data memorandum lists 63 standard and 58 special analyses. **Circle L17 inside back cover.**

VHF Receiver. Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y. Brochure R-9903 fully describes the Servoflight R5200 vhf communications receiver. The receiver discussed meets all the prime specifications of wide frequency range, high order of accuracy, maximum sensitivity, high frequency stability, and also provides automatic noise limiter, squelch, continuous tuning without switching, and continuous operation.

Part of the development story of the R5200 is the special atten-

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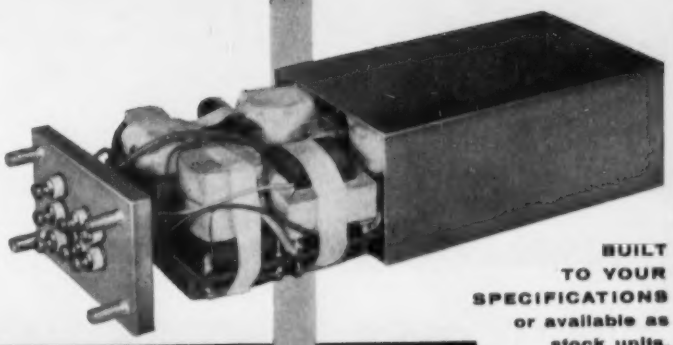

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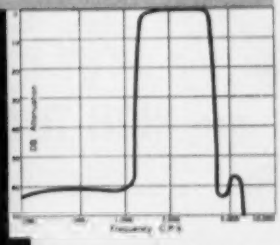

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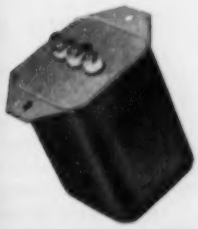
Typical
Band-Pass Filter



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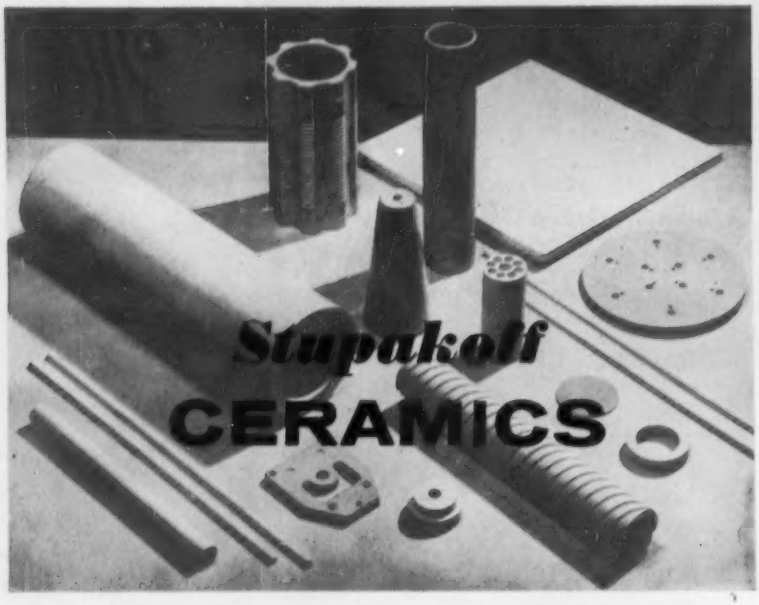

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Stupakoff offers a number of ceramic bodies providing exceptional resistance to thermal shock, the most outstanding being STUPALITH, which has withstood over a hundred cycles from 2000° F to liquid air without harm.

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tion given to its mechanical design to assure simplicity in servicing. The r-f tuner and the complete i-f strip are constructed as separate, self-contained units which can be readily removed from the main chassis. Once removed, they may be operated separately, or in conjunction with each other. **Circle L18 inside back cover.**

Pulse Transformers. Technitrol Engineering Co., 2751 North Fourth St., Philadelphia 33, Pa., has announced a bulletin on pulse transformers of particular interest to design and production engineers. Different core materials and variations in windings and sizes allow the rapid production of a number of series and types within each series, all encapsulated, to fit many standard circuits.

Also offered are custom-wound pulse transformers to fit special circuits such as transistor, printed and military types. **Circle L19 inside back cover.**

Tiny Electrolytics. Gary Wells Co., 3 Park Row, New York 38, N. Y. Bulletin H covers a complete line of miniature electrolytic capacitors which are encased in solid-drawn single-ended aluminum cans spun on to plastic end plugs to give a moisture-proof seal. Included are data on tolerance, power factor and leakage current as well as a dimension chart. Because of the low prices discussed, these capacitors are particularly suited for radio-tv-phono and similar applications. **Circle L20 inside back cover.**

Deposited Carbon Resistors. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Bulletin B-4 contains comprehensive data on construction, applications, types, dimensions, performance and tolerance. Detailed charts and graphs are shown in the 4 pages. **Circle L21 inside back cover.**

Electronic Timer. G. C. Wilson & Co., 1915-8th Ave., Huntington, West Va., has available an 8-page brochure with current information and specifications describing its standard line of electronic timers now being manufactured. Included

in the line described are delay, repeat cycle and interval timers. **Circle L22 inside back cover.**

Calibrated Load. Color Television Inc., 935 E. San Carlos Ave., San Carlos, Calif. A new leaflet illustrates and describes the model 128A X-band calibrated load, an adjustable mismatch load which is calibrated at three frequencies and at four vswr's. Specifications included cover the standard calibration frequencies and vswr's, the accuracy, type of waveguide fitting, dimensions and price. Listing is made of the availability of special calibrations where required. **Circle L23 inside back cover.**

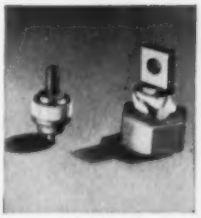
Development in Miniature. Cook Electric Co., 2700 North Southport Ave., Chicago 14, Ill., through *Newsletter* Vol. 1, No. 30, announces the availability of a new voltage standard, an acceleration switch, and a 5-ampere spdt relay. Any of the miniatures discussed are furnished in hermetically sealed cases with a volume of less than 1 cu in. and weigh less than 2 oz. **Circle L24 inside back cover.**

Automatic Instrumentation. Fairchild Electrotechnics, Division of Fairchild Engine and Airplane Corp., 118 E. 16th St., Costa Mesa, Calif., has available a folder and technical bulletins describing its automatic instrumentation components and systems. Topics covered in the bulletins include: resistance bridge indicator, voltage ratio indicator, miniature bridge balance and warning systems.

Readers need write only once and they will receive each new technical bulletin, describing components and systems now under development, as they are published subsequently. These supplementary bulletins can be filed in the same folder if desired. **Circle L25 inside back cover.**

Thermocouple Insulators. Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill., has issued a new bulletin No. 300-56 illustrating and describing the complete line of Serv-Rite thermocouple insulators. Listed are the dimensions, sizes

Stupakoff
METAL-BONDED
ALUMINA TERMINALS



Right—Sample of a Stupakoff Alumina Terminal in test rig, torsion-tested to destruction. The failure occurred in the ceramic, not in the bond.

Left is similar terminal before testing.

Amazing bond-strength, and unequalled high-temperature ceramic-to-metal adherence are two outstanding characteristics of Stupakoff Alumina Terminals. Available in six standard stock sizes and many special designs, these terminals provide assurance of stronger, tighter, soft-soldered assemblies. The alumina body is a Stupakoff development, processed under rigidly controlled conditions.

The new Stupakoff metal-bond technique (patent applied for) should not be confused with the ordinary silver metallizing process. This is not a plating, but an intimate bonding of ceramic and metal. Its effectiveness is proved by the photograph at the left, showing the results of a typical torsion test. Ultimate failure of the terminal occurred in the ceramic and not in the bond.

Because the bond remains hermetically tight well beyond the temperature limits of soft solder, assembly processes are simplified and more dependable.

Write for full information and prices on Stupakoff Metal-Bonded High Alumina Terminals.

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and types of insulators available for high thermal shock, high temperature and high mechanical strength. The principal properties of the different materials are included as an aid in selection. **Circle L26 inside back cover.**

Fuse Resistor. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Catalog data bulletin P-3 covers the type FR fuse resistor. Comprehensive data on applications, advantages, design, construction, ranges, tolerance, stamping and derating are given. Detailed charts and graphs are included. **Circle L27 inside back cover.**

Selenium Rectifiers. General Electric Co., Schenectady 5, N. Y. The 12-page bulletin, GEA-6545, gives features, application, charts, construction, dimensions, specifications and other data on ¾ kw to 125 kw selenium rectifiers as well as multiples to 500 kw. **Circle L28 inside back cover.**

Panel Instruments. Triplett Electrical Instrument Co., Bluffton, Ohio, has published a comprehensive new panel instrument data sheet, Form 81556-T. The 4-page form contains full-size scales of various types of panels as well as dimensional diagrams of round, rectangular and special instruments on which panels are used.

Typical external shunts, illustrated for purpose of showing mounting dimensions, as well as illuminated meters are also shown in the data sheet. **Circle L29 inside back cover.**

Ferramic Magnetic Cores. General Ceramics Corp., Keasbey, N. J. Bulletin MT-103 is a 4-page folder describing the magnetic properties of Ferramic S-1. Tabular material and characteristics charts are included. The cores described are available in more than one grade each, embodying a different set of characteristics. **Circle L30 inside back cover.**

Antenna Handbook. I-T-E Circuit Breaker Co., 601 E. Erie Ave., Philadelphia 34, Pa. A new 14-page handbook containing a

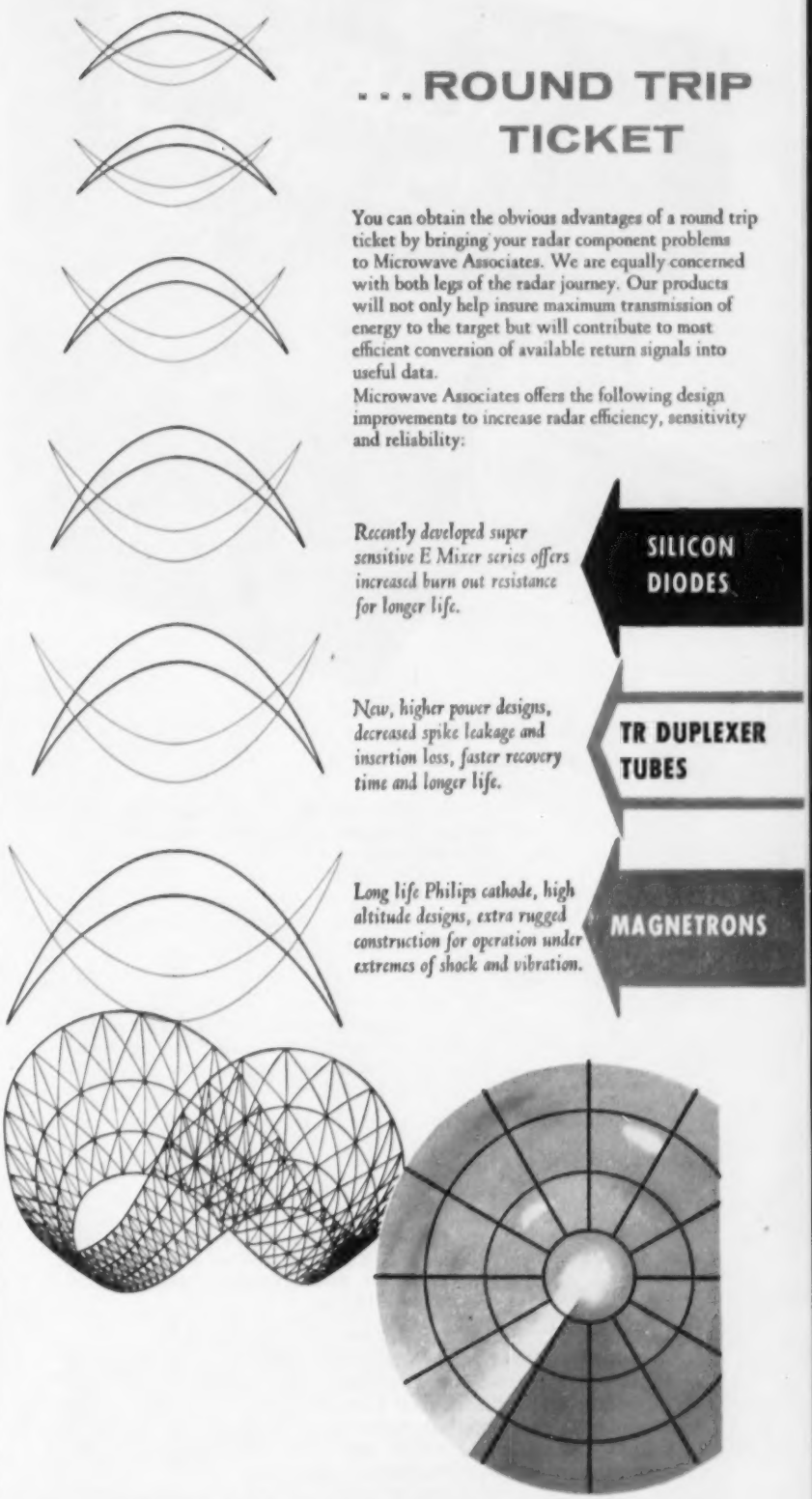
selected group of curves of antenna characteristics has recently been announced as an aid for engineers working with microwave antennas or systems involving such antennas. **Circle L31 inside back cover.**

Magnetic Controls. Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa. Cypak magnetic controls and logic functions for industrial control are discussed in an 8-page booklet (TD 52-760) now available. Illustrated with photographs, drawings and circuit diagrams, the booklet discusses the basic "and", "or", "not", and "memory" logic functions; the circuitry providing these functions, including the basic Ramey magnetic amplifier circuit; and current applications to industrial control. **Circle L32 inside back cover.**

Transformers. Transonic Inc., 808 Sixteenth St., Bakersfield, Calif. An 8-page well-illustrated folder shows the company's manufacturing and testing facilities for a wide line of transformers. Typical products listed, which are engineered and manufactured by the company, include: high altitude units, wave filters, power transformers, high power audio units, instrument transformers, pulse transformers, geophysical units, current limiting transformers, wide-band transformers, saturable reactors, blocking oscillator pulse transformers and specialty magnetic core products. **Circle L33 inside back cover.**

Constant Voltage D-C Power Supplies. Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill., has available a booklet (DC-235) giving technical data for six, standard-design, regulated d-c power supplies for intermittent, variable, and pulse loads, or high-amperage loads. The text is amply illustrated with photographs, schematic drawings, and tables showing mechanical and electrical specifications and performance data. These d-c power supplies combine a constant voltage transformer, a germanium power rectifier and high-capacitance filter without choke.

The theory of operation of the



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for WIDEST OPERATING TEMPERATURES

. . . Aerovox metallized-paper capacitors are available in a wide variety of case styles for operation at temperatures ranging from −65°C to +125°C.

Aerovox metallized-paper capacitors were developed specifically to meet today's critical requirements for capacitors of improved reliability and reduced size. Complex electronic gear such as guided missiles, computers, airborne receivers, telephone switchboards, transistorized radios and color TV have successfully applied Aerovox metallized-paper capacitors.

power supplies is covered in detail in the booklet, with oscillograms, schematic diagrams and charts showing output voltage curves for a typical power supply assembly at various loads and supply line voltages. Ratings for the 6 stock d-c supplies are shown on specification charts. More than 30 other ratings are offered on special order.

The booklet has 8 pages, measures 8½ in. by 11 in. and is prepunched to fit a standard 3-ring binder. **Circle L34 inside back cover.**

Paper Tubulars. Aerovox Corp., New Bedford, Mass. A 16-page catalog describes capacitors of the tubular type, having casings of ceramic or organic materials.

The catalog covers units designed for radio-television and instrument applications and contains impregnant charts, dimensional drawings, color-code charts and rating tables. **Circle L35 inside back cover.**

Magnetic Memory Planes. General Ceramics Corp., Keasbey, N. J. Bulletin MP-105 covers a line of completely assembled coincident-current magnetic memories for computers, switching, automatic control and systems. Applications, specifications and data on standard configurations for the Ferramic magnetic memory planes are included. **Circle L36 inside back cover.**

Rotary Solenoids. Oak Manufacturing Co., 1260 North Clybourn Ave., Chicago 10, Ill., has prepared a new 2-color, 8-page booklet to describe and illustrate its line of high-torque rotary solenoids. The solenoids discussed feature instant starting, uniform force throughout the stroke and rugged construction.

The booklet contains a dimensional chart, mechanical supplements and 8 complete engineering data charts. **Circle L37 inside back cover.**

Liquid Rosin Flux. Alpha Metals, Inc., 56 Water St., Jersey City, N. J. A new 2-page technical bulletin giving a complete description, uses, properties and methods of

application of the No. 100 nonactivated liquid rosin flux is now available. A helpful graph showing the concentration-density relationship of No. 100 flux and No. 400 flux thinner is included.

This information will be of particular interest to those involved in the problems of electronic and printed circuit soldering. **Circle L38 inside back cover.**

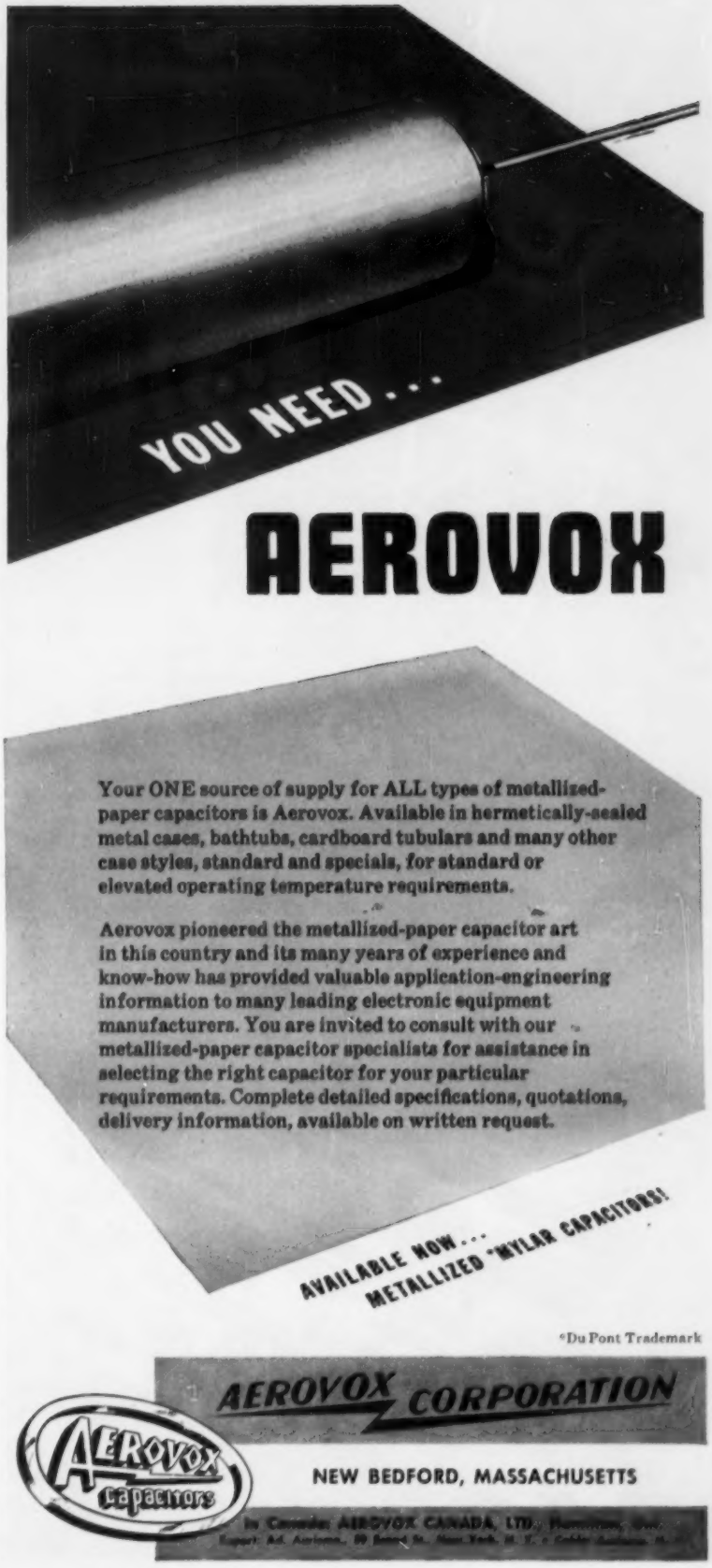
Large Waveguide. I-T-E Circuit Breaker Co., 601 E. Erie Ave., Philadelphia 30, Pa. Bulletin EPW-656 provides mechanical and electrical characteristics and standard shape data on the latest type waveguide for multi-megawatt radar and communications systems. Sizes described are from WR770 and larger with maximum vswr limited to 1.05 for bends and 1.03 for straight sections over the entire operating band. **Circle L39 inside back cover.**

Systems and Products. Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y. A new 16-page short form catalog (SF9901) describes the various systems, equipment and components manufactured by the company.

Included are the Servomation building block servo-synthesis equipment, Servoscope servo system analyzer, Servoflex servo amplifiers, Servoboard electromechanical assembly kits, spectrum signal generator, Servotherm pyrometers, infrared radiation standard, heat detector cells and accessories, UV-IR photometer, Servoflight dead reckoning tracer, h-f direction finder and vhf communications receiver. **Circle L40 inside back cover.**

Process Instruments. Beckman Instruments, Inc., 2500 Fullerton Road, Fullerton, Calif., has available a 4-page bulletin on its process instruments. The brochure contains pictures and brief descriptions of the Beckman electrolytic hygrometer, L-B infrared analyzer, leak detector, flow colorimeter, micro-microammeter, r-f gas analyzer, pH control system and the 111 data system.

Information on how to obtain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Aerovox pioneered the metallized-paper capacitor art in this country and its many years of experience and know-how has provided valuable application-engineering information to many leading electronic equipment manufacturers. You are invited to consult with our metallized-paper capacitor specialists for assistance in selecting the right capacitor for your particular requirements. Complete detailed specifications, quotations, delivery information, available on written request.
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additional data on the various instruments for process analysis, measurement and control is also contained in the bulletin. **Circle L41 inside back cover.**

Precision Potentiometer. Helipot Corp., Newport Beach, Calif. The new 1 7/16 in. diameter series 5400 precision potentiometer is the subject of data sheet 54-44. The unit described is a single-turn, continuous-rotation unit for servo or bushing mounting, and available with or without ball bearings. The data sheet is illustrated and lists specifications, construction, coil characteristics and available modifications. **Circle L42 inside back cover.**

Magnetic Memories. General Ceramics Corp., Keasbey, N. J. The operation of coincident current Ferramic magnetic memories is covered in technical bulletin No. MM-1. The 8-page bulletin is the first of a series on Ferramic square hysteresis loop materials for design, development and production personnel. A bibliography is included. Engineering assistance available is mentioned. **Circle L43 inside back cover.**

Analog Computer. Reeves Instrument Corp., 207 E. 91st St., New York 28, N. Y., announces a new 16-page brochure illustrating and describing the advanced design features of the 400 series REAC analog computer.

The brochure details the many new "firsts" incorporated in this computer—first problem check system, first time scale check system, first plug-in servo padding turrets, first 400-cycle high performance servo, first automatic recording of recorder calibration data.

The modular building-block construction of the 400 series is described, along with a general description of component operation. A special section is devoted to the completely redesigned high-stability d-c amplifiers used in the computer. **Circle L44 inside back cover.**

Solder Core Contacts. DeJUR AMSCO Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. Technical bulletin on new solder

core contacts for Continental connectors includes illustrations, descriptions and specifications covering perfected method of pre-filling contacts with a solder alloy of any specified composition. **Circle L45 inside back cover.**

Electrical Insulating Materials. Furane Plastics Inc., 4516 Brazil St., Los Angeles 39, Calif., has published a complete chart of formulated epoxy resins giving physical and electrical data on 27 resin systems.

Introduced on the chart is Epocast 18, a one-compound epoxy resin which cures at elevated temperature. It is not necessary to add hardener to Epocast 18, which has demonstrated good stability at room temperature.

The chart shows a multiple choice of hardener for several epoxy resin systems—offering fast or moderate cure—with and without safety hardeners. **Circle L46 inside back cover.**

Transistorized Equipment. Electronic Research Associates, Inc., 67 East Centre St., Nutley, N. J., announces a new 8-page 2-color catalog covering their complete line of transistorized and tubeless equipment. It describes test equipment, power supplies, packaged circuits, miniaturized components, constant current generators and other items. Included in the catalog is the company's new line of high efficiency transistorized power supplies which are intended to replace vacuum and magnetic amplifier equivalents wherever used. **Circle L47 inside back cover.**

Plug-In Circuitry. The Walkirt Co., 145 W. Hazel St., Inglewood, Calif., has available 2-color data sheets pointing up new features of its line of plug-in units. Included in the changes described are: plastic banding color code for immediate group identification; gray gloss finish of tough baked urea alkyd enamel, embedment in mica-filled epoxy, rather than polyester resin, as before; and for maximum legibility, direct-printed nomenclature on face of each unit.

Other construction and performance factors in the redesigned

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From advanced know-how and industrial chemistry . . . came "Teflon." Through unique applications of "Teflon" on wire and cable . . . Hitemp Wires, Inc. has opened new horizons for the electronic and electrical industries.

With "Teflon" insulated wire, tubing, multi-conductor cables, lacing cord, tape and sewing thread, miniaturized electronic and electrical components are now possible . . . with the amazing working temperature range of —90°C to +250°C.

"Teflon" insulated products offer this unexcelled combination of properties: low loss factor, low dielectric constant, high volume resistivity, nonflammable, low coefficient of friction, unaffected by moisture, tough . . . yet flexible, and completely inert to all known commercial solvents.

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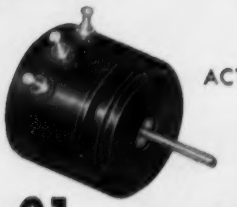
*DuPont's Trade Name for POLYTETRAFLUOROETHYLENE

NEW Jewel-bearing "LO-TORK"



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Jewel bearings for lowest torque, and superior seal against surroundings that contain abrasive dust, make this new, Model LLT ⅞ Waters pot the ideal unit for high-reliability service where minimum torque is essential. With torque low enough to permit actuation by a Bourdon tube or a bimetallic thermal element, this potentiometer offers new advantages in sensitive-instrument applications as well as in computer, servo, and selsyn uses. Check your needs with these specifications:

Maximum torque: .....0.01 ounce-inch
Dissipation: .....one watt at 80° Centigrade
Resistances: .....100 ohms to 100,000 ohms
Weight: .....½ ounce
Outside diameter: 0.885 inch Body depth: ⅞ inch
Linearity: 0.5% standard; on special order, 0.25%
Winding angle: 354° standard; on special order, 360°
Ganging: to six decks with no increase in diameter.

Where the features of a ball-bearing potentiometer are desirable, specify Waters Model LT ⅞ "Lo-Tork" potentiometer.

Write for data sheets on jewel-bearing and ball-bearing precision wire-wound potentiometers.

Do you ever need pots that are "just a bit different"? Maybe we can help you — by modifying a standard Waters design or by taking a bold, new approach. Tell us your need and we'll tell you what we can do.

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line are stressed, such as shock and vibration resistance, moisture-proof construction. Catalog No. 11386 also points up the company's other stock lines—counters, multivibrators, amplifiers and pulse generators. **Circle L48 inside back cover.**

Miniature Electrical Connectors. The Deutsch Co., Los Angeles, Calif., has announced a new 8-page, 2-color catalog illustrating and describing its complete line of miniature electrical connectors. The catalog presents standard plugs and receptacles and features the two newest additions to the Deutsch line: push-pull miniature connectors and spherical orientation (rack and panel) connectors.

The standard connectors listed in the catalog include: bulkhead mounting square flange and cable clamp receptacles; standard, cable clamp and lanyard plugs; hermetic, and rack-and-panel receptacles. Connector accessories are also listed and illustrated.

The catalog notes that the push-pull connectors are designed for crowded, inaccessible and ballistic installations, where space is at a premium and where lock-wiring or twisting is impossible or impractical. The spherical orientation connectors described are designed to self-align and mate in blind connections. **Circle L49 inside back cover.**

Color Difference Meter. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Avenues, Philadelphia 44, Pa. Data sheet 10.10-6 describes color theory, accuracy and features of Gardner automatic color difference meter with Brown ElectroniK amplifier and motors. The meter discussed gives three-part numerical comparison of color samples. **Circle L50 inside back cover.**

Safety Amplifier. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Avenues, Philadelphia 44, Pa. Specification S901-1 describes and illustrates the Brown safety amplifier for nuclear reactor control. The amplifier discussed can be used with electric clutches, solenoids and similar de-

vices, as well as with electromagnets, because fast-acting relays initiate complete, irreversible scram. **Circle L51 inside back cover.**

Magnetrons and Traveling-Wave Tubes. Radio Corp. of America, Harrison, N. J. Prepared to assist those who work with microwave tubes and circuits, the 40-page booklet MT-301 describes the theory of operation of magnetrons and traveling-wave tubes, presents operating considerations and applications, and gives techniques for measurement of important electrical parameters. Illustrations included show the structural parts of both types of tubes, typical performance characteristics, test methods and representative circuit applications. Data are given for four commercially available RCA magnetrons and one t-w tube. An extensive list of references is also included. Price of the booklet is 50 cents. **Circle L52 inside back cover.**

Digit-Matic Printers. Victor Adding Machine Co., 3900 North Rockwell St., Chicago 18, Ill., has available a new 12-page manual on its Digit-Matic printers. The units described are basic adding, multiplying, or calculating machines equipped with electrically actuated keys. Thus figures can be entered into the machines electrically and at high speeds.

The literature covers all operating specifications for digital printers, and provides details on many types of special calculating and printing techniques. Illustrations, special features and circuitry are included. **Circle L53 inside back cover.**

Printed Circuit Connectors. Anton Electronics Laboratories, Inc., subsidiary of U.S. Hoffman Machinery Corp., 1226 Flushing Ave., Brooklyn 37, N. Y. A recent catalog data sheet covers the PCD22 printed circuit, double contact connector receptacle for use with a $\frac{1}{16}$ in. PC board having 22 individual contacts on each side of the board.

Listed features of the connector described are: (1) use of a flat

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an inestimable benefactor of mankind
... He will be remembered
when all the rest of us are long forgotten."

A statement by HERBERT HOOVER at a
Testimonial to Dr. de Forest, April 8, 1952

Dr. Lee de Forest

His invention of the 3-Electrode Grid Vacuum Tube fifty years ago in 1906 was the birth of today's Electronics Industry.

THE WHITE HOUSE
WASHINGTON

March 16, 1956

Dear Dr. de Forest:

... I congratulate you on your many contributions to scientific progress. Through your long and distinguished career you must have experienced many moments of pride that your imagination and talent furthered the development of modern radio, television and radar. You must also feel great satisfaction in remembering your past decades of service and in anticipating future achievements that your handiwork has made possible ...

Sincerely,

Dwight D. Eisenhower

The Measure of a Mighty Contribution

Of all the creations shaped by his genius, Dr. de Forest's 3-element grid Audion tube — the miracle seed responsible for the swift growth of electronics — best reflects his enormous gift to mankind.

To understand this vastness, appraise the value of the lives spared in wartime and protected in peacetime ... and add these seemingly limitless electronic inventions fathered by his precious Audion.

This space is sponsored by a member of the electronic industry in grateful acknowledgement of Dr. de Forest's contribution to mankind.

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Built to surpass MIL-R-93A
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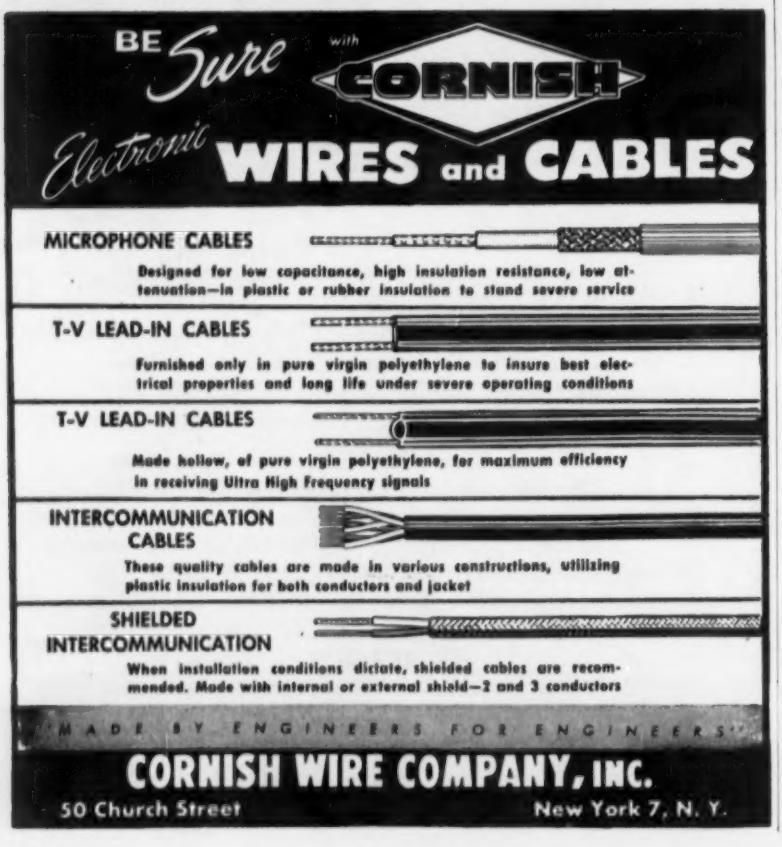
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contact (for easy insertion) backed up by a double-thick reinforcing spring for positive contact and virtually infinite life; (2) a full kick-out on the contact to hold it in securely, or to enable removal by compressing the kickout; (3) various retention contact forces on special order; (4) uniformly heat treated flat wire Beryllium copper contacts. Applications and specifications are included. **Circle L54 inside back cover.**

Constant Voltage D-C Power Supplies. Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill., is offering a technical bulletin on the DC Solavolt—a new, adjustable-output, constant voltage d-c power supply. The bulletin discusses features and applications of six stock DC Solavolts, and gives electrical and mechanical specifications for each.

The 4-page publication, DC-245, is pre-punched to fit a standard 3-ring binder. **Circle L55 inside back cover.**

Molded Boron Carbon Resistors. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Comprehensive data on construction, applications, types, tolerance, resistance element, terminals, insulation, dimensions, performance and characteristics are included in bulletin B-8. Detailed charts and graphs are shown. **Circle L56 inside back cover.**

R-F Gas Analyzer. Beckman Instruments, Inc., Fullerton, Calif., has available a 4-page brochure containing latest information on its r-f gas analyzer. The instrument is described and illustrated in detail in bulletin 488 which contains application information as well as instrument performance and specifications.

The r-f gas analyzer is described as a compact, rugged mass spectrometer which combines analytical versatility, simplicity and low cost with ease of operation, portability and performance. It can be used both as a continuous stream analyzer or routine laboratory instrument. Important basic information in exploratory work such as oil well mud logging and pilot

plants are just a few of the many uses for the instrument discussed. **Circle L57 inside back cover.**

Miniature Camera Tube. Resitron Laboratories, Inc., 2908 Nebraska Ave., Santa Monica, Calif. A recent bulletin illustrates and describes the Resitron 6912, a 1½ in. dia. photo-conductive camera tube ideally suited for tv broadcast, industrial tv, aircraft and military applications where portability, size and weight considerations are important. Tube dimensions, base connections and operating characteristics are shown. **Circle L58 inside back cover.**

Convergence Dot Generator. Foto-Video Laboratories, Inc., 25 Amity St., Little Falls, N. J., has released its latest catalog information on its model V-6 convergence dot generator. The unit discussed is used for adjustment of the convergence of shadow mask tricolor kinescopes as used in color tv receivers or monitors, and also checks linearity of both color and monochrome monitors or receivers.

This specification sheet contains descriptions of the features, applications and specifications of the unit, plus illustration. **Circle L59 inside back cover.**

Power Supply and Bridge Control. Gow-Mac Instrument Co., 100 Kings Road, Madison, N. J. Bulletin SPS 8-56 contains an illustrated description of the model 9293-B power supply and bridge control, a compact instrument that has all the circuitry and controls necessary for operation of a Gow-Mac four filament T/C cell for gas chromatography or other instrumental gas analysis both intermittent and continuous. Chief features, specifications and prices are included. **Circle L60 inside back cover.**

Audio Units. James B. Lansing Sound, Inc., 2439 Fletcher Drive, Los Angeles 39, Calif., has issued a 6-page leaflet (catalog SC502) with illustrations and descriptive data on its current line. Products covered include extended range speakers, low and high frequency drivers, dividing networks, and

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5900 Series: For time delay or interval timing in ranges from 0 to 10 minutes.

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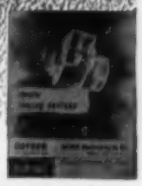

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several models and styles of enclosures. Prices are given. **Circle L61 inside back cover.**

Vinyl Electrical Tapes. Permacel Tape Corp., New Brunswick, N. J., has prepared a brochure describing the qualities and applications of plastic electrical pressure-sensitive tapes made of a specially formulated vinyl. The illustrated brochure presents the Permacel vinyltapes as resistant to the four major causes of insulation failure —moisture, surface contamination, excessive heat and the discharge of surface electricity.

A section of the brochure also is devoted to Permacel 291, suitable for electroplating applications where a stop-off tape with high adhesion is needed. **Circle L62 inside back cover.**

Machine Tool Control Systems. Farrand Controls, Inc., 4401 Bronx Blvd., New York 70, N. Y. Bulletin 819 describes the Inductosyn linear and angular micropositioning systems. The linear type described is an electronic automatic machine tool control capable of automatically positioning the carriage of a machine tool with a maximum linear error of 0.0001 in. or positioning a rotational member with a maximum angular error of 5 sec of arc. The rotary type discussed can be used as an electromechanical dividing head, a multispeed data transmission system, a high precision position servo, an electronic back-lash-free gear ratio, a high speed electromechanical phase shifter or an angular pick-off accurate to ±5 parts per million. **Circle L63 inside back cover.**

Rate Gyros, Accelerometers, Potentiometers. Humphrey Inc., 2805 Canon St., San Diego 6, Calif. Three new technical bulletins containing photos, descriptions and general specifications of rate gyros, accelerometers and potentiometers are now available.

Bulletin R-100 offers information on four basic series of rate gyros ranging from a miniature gyro, suitable for stabilization systems and instrumentation, to one developed specifically for systems in which position information is

obtained by integrating the rate gyro output.

Bulletin A-100 describes three basic series of accelerometers including series LA03-0200, the smallest and lightest being used in production instrumentation and control systems.

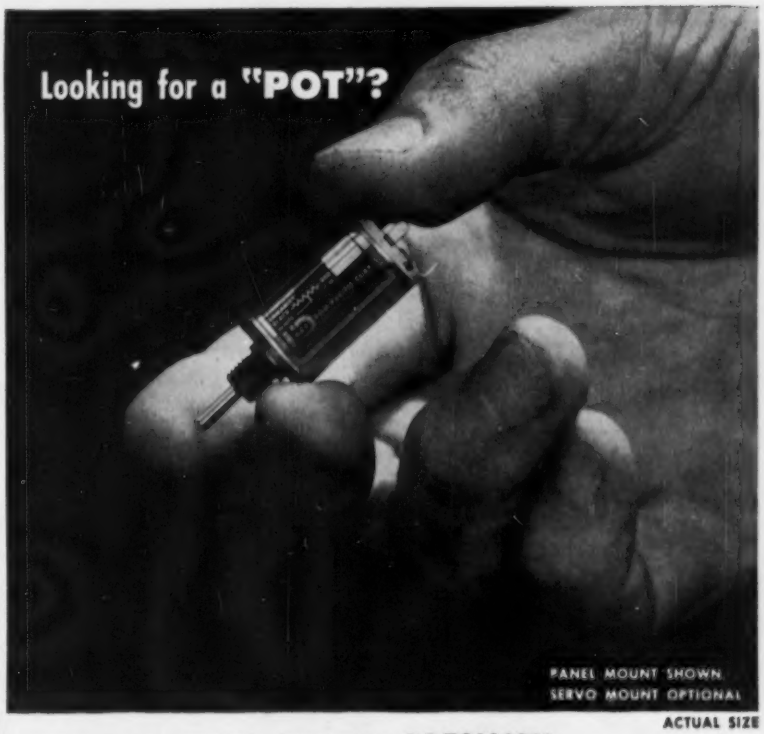
Bulletin P-100 covers a variety of types and models of potentiometers now being manufactured by the company. **Circle L64 inside back cover.**

Unit Thermistor Controller. Fenwal Inc., Ashland, Mass., offers an illustrated brochure describing its series 53000 thermistor-actuated temperature controller. The controller discussed is designed as an individual unit which is plugged into a separate power supply chassis. For multi-point control, the brochure shows how the requisite number of controllers can be plugged into a single power supply chassis, thus centralizing control and conserving space, but maintaining a choice of locations for temperature adjusting controls.

Also described in bulletin MC-133 are the thermistor sensing elements whose excellent sensitivity and stability permit control as close as 0.25 percent of scale range, and lead wires 200 ft and more in length. **Circle L65 inside back cover.**

Precision Potentiometer. Helipot Corp., Newport Beach, Calif. The series 7700 precision potentiometer is the subject of data sheet 54-26. The 10-turn metal-housed unit described is available with either air-core or copper-mandrel windings in a wide range of total resistance. Advantages of the new potentiometer are covered by specifications and illustrations; including construction, coil characteristics and modifications available. **Circle L66 inside back cover.**

Thermal Conductivity Cell. Gow-Mac Instrument Co., 100 Kings Road, Madison, N. J. A 2-page data sheet deals with the model TR-11-B thermal conductivity cell for 200 C operation. Included are illustrations, description, general specifications, a circuit diagram and operating specifications. **Circle L67 inside back cover.**



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Smaller in diameter than a fountain pen — no longer than a shriveled up Gryllidae Gryllus*, this tiny "pot" offers ultimate precision in the smallest package on the market.

Check some of the standard specifications of this precision-built, wire-wound, ten-turn potentiometer:

SIZE:	**17/32" x 1-1/8"**
WEIGHT:	**10 gms. max.**
BACKLASH:	**Essentially Zero**
PHASE SHIFT:	**Less than 0.1° at 4000 cps.**
VIBRATION:	**10gs to 500 cps (3 attitudes)**
LINEARITY:	**Best Practical 0.05%**

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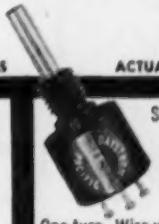


Series 304

One-turn, Wire-wound, Precision Potentiometer.

LOW COST HIGH PERFORMANCE

Plants and People

Edited by WILLIAM G. ARNOLD

Electronics manufacturers continue plant and facility expansions through new construction and additions or acquisition of existing plants. Engineers and executives shift to new positions in the industry. Societies elect officers

Levinthal Electronics Builds New Plant In Stanford Park

CONSTRUCTION has started on the first unit of a 55,000 sq ft facility in Stanford Industrial Park in Palo Alto, Calif. for Levinthal Electronic Products. The new plant will augment the present installation in Redwood City, Calif. Space will be devoted to administrative engineering, and research activities relating to work in high-power microwave equipment for radar, data transmission, missile guidance, and telemetering and scintillation-crystal development under an Atomic Energy Commission contract. Specialized medical electronic equipment, particularly that relating to the detection and measurement of electrical activity in the body and for therapy of electrical malfunction of the heart will be produced in the plant.

F. E. Terman, dean of engineering and provost, Stanford University, left, attends groundbreaking ceremonies for new plant of Levinthal Electronic Products along with Elliott Levinthal, president, and Albert J. Morris, vice-president of the company.

Levinthal also announced that Eli M. Goldfarb was named senior project engineer. Prior to joining Levinthal, Goldfarb was a research associate in the Electronics Research Laboratory at Stanford University on microwave electron devices. Prior to that he was a research engineer in the Jet Propulsion Laboratory at the California Institute of Technology, Pasadena, working on guided-missile computer design and other electronics projects.

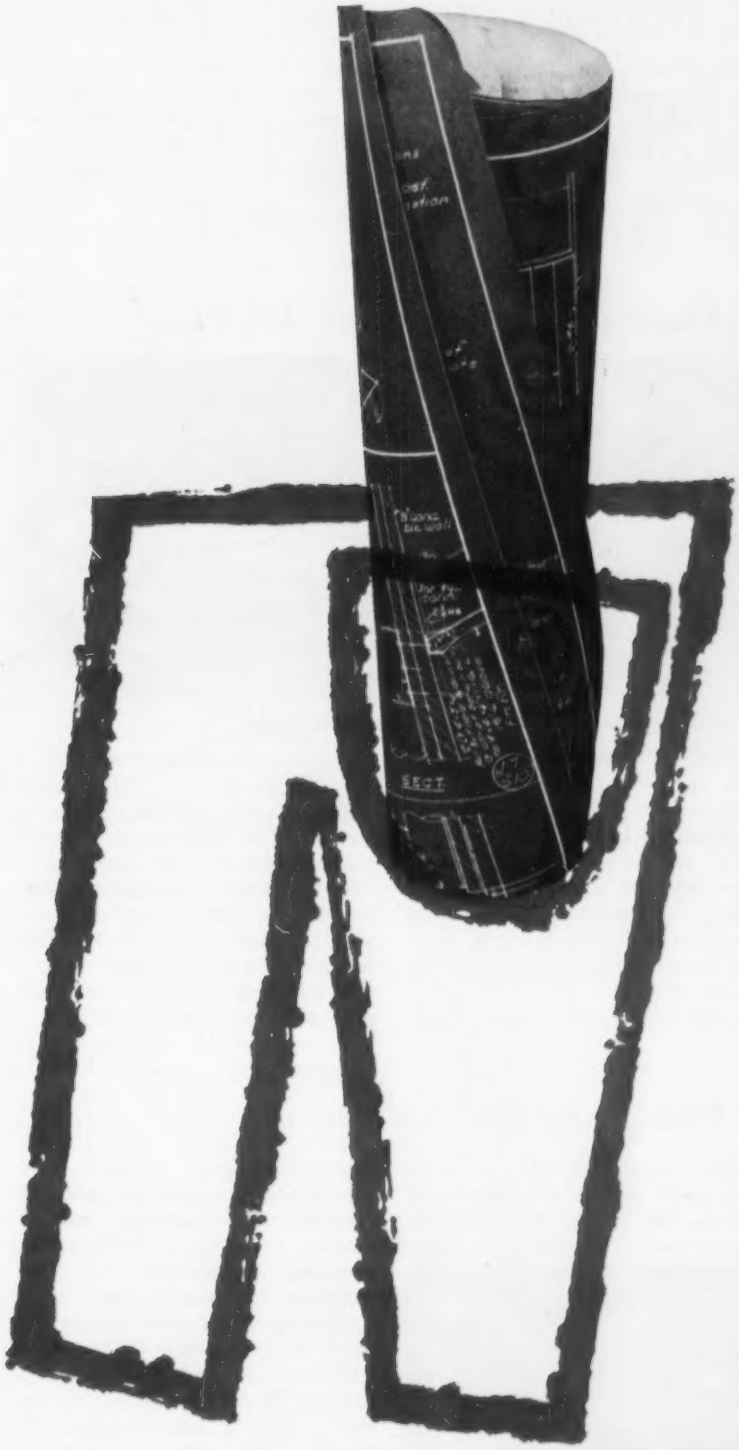
Westinghouse Dedicates Research Labs, Plans Addition

New Westinghouse research laboratories near Pittsburgh

WESTINGHOUSE Electric dedicated its new research laboratories near Pittsburgh, Pa. The building is situated on a 72-acre site and has almost a third of a million sq ft of floor space. The laboratories employ more than 700 people of which over 450 are professional scientists, laboratory technicians and assistants.

The move from the old laboratories in Forest Hills, Pa., to the new location more than doubled research facility space. Ground was broken for the new labs in 1953. Occupation began last year.

Construction is expected to start this fall for an addition to the new laboratories that will house approxi-



have an idea in your hip pocket?

Then we have an idea you'll be happiest at Firestone... where ideas are most likely to see the light of day and breathe the air of success. Here, too, you'll discover benefits and attitudes inspire more ideas, more success.

Ideas—and men with ideas—have kept Firestone at the top of the pioneers-in-progress list for 56 years. Right now, we're carrying forward the Army's vital program for the "Corporal," first surface-to-surface ballistic guided missile. This includes development engineering, field test and service, and missile and component production.

But the need for good men with good ideas grows... because Firestone plans to keep growing in this field. For instance, here are just a few specific needs—a few from a list too long to show in full:

Component Design
Electronics Systems
Mechanical Systems
Flight Simulation
Field Engineering

There's a man at Firestone with ideas—good ideas—on your future. Why not write today?

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GUIDED MISSILE DIVISION

RESEARCH • DEVELOPMENT • MANUFACTURE

"Find your Future at Firestone"—Los Angeles • Monterey

WRITE: SCIENTIFIC STAFF DIRECTOR, LOS ANGELES 54, CALIF.

mately 159,000 sq ft of space. This 50 percent expansion will be for the materials engineering department now located in East Pittsburgh. The addition itself will be larger than the old Forest Hills laboratory.

▶ **Program**—About 30 percent of the Laboratories effort is in "blue sky" projects, in work fundamental to the electrical industry but not directed toward a particular product development. About 55 percent is co-ordinated with long-range plans of product divisions, most of it being basic research. Eight percent is taken up in governmental activity, seven percent is devoted to product development, mostly in highly specialized fields of research endeavor.

Baldwin-Lima Opens Electronics And Instrumentation Plant

BALDWIN-LIMA-HAMILTON CORP. opened a new $3 million plant at Waltham, Mass. to house its entire electronics and instrumentation division. The division will manufacture testing instruments, SR-4 strain gages and testing systems, testing machines and allied equipment. These products were previously handled by four Baldwin-Lima organizations: Ruge deForest of Cambridge, Mass., O. S. Peters Co. of Washington, D. C., Sonntag Scientific Corp. of Greenwich, Conn., and the testing equipment department of the Eddystone division of Baldwin-Lima-Hamilton in Phildelphia, Pa.

The four organizations have coordinated their manufacturing for more than a year in spite of geographical separation. They were consolidated last year into the electronics and instrumentation division.

John R. Martin, Baldwin vice-president, is general manager of the new plant.

New plant for Baldwin electronics and instrumentation division

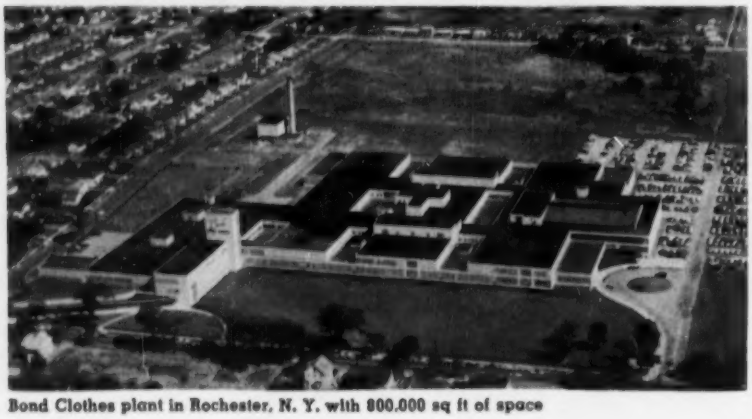
The new plant, located in the Waltham research and development park, was completed six months from the date of ground breaking. The 102,000 sq ft of floor space in the plant is divided into 92,000 sq ft for manufacturing operations and 10,000 sq ft for offices. The plant employs 525 people and has a payroll of a quarter of a million dollars per month.

The new division, which will have a production capacity one third greater than the combined capacities of the three companies brought together to form it, will have an initial product output of $700,000 per month and good prospects of increasing this output to $900,000 per month by the end of 1956.

Stromberg To Buy Bond Plant, Appoints Engineers

STROMBERG-CARLSON division of General Dynamic Corp. plans to purchase the Bond Stores factory in Rochester, N. Y.

The company plans to make the new plant into an electronics research, engineering and manufacturing center. Plans are now being prepared to move the company's research-advanced development and electronics engineering departments, automation engineering, electronics production facilities, government contract administration, national television service department, and certain warehousing facilities, into the new plant. It is expected that these moves will be made gradually over a number of months as the space becomes available.



Bond Clothes plant in Rochester, N. Y. with 800,000 sq ft of space

This will make all manufacturing facilities at the firm's Carlson Road headquarters available for the production of telephone apparatus and related communication equipment.

The company's executive offices also will remain at Carlson Road,

in the new building now under construction.

Approximately one year ago Stromberg-Carlson broke ground for a new $5 million administration-research building and an addition to its manufacturing plant on Carlson Road. A portion of this structure, to be used for manufacturing purposes, will be occupied this fall, and the remainder is scheduled for occupancy in 1957.

When this building is completed the Carlson Road plant will provide a total of approximately 800,000 sq ft of floor space.

The Bond plant contains 800,000 sq ft of floor space, and was built in 1948-49, and first occupied in 1950. The building is located on a 57½-acre site.

▶ **Appointments**—Stromberg-Carlson-San Diego appointed Howard W. Grossbohlin as head of the tube and component department, and Robert M. Peterson as assistant chief engineer in charge of electronics engineering.

Principal product of Stromberg-Carlson-San Diego is the Charactron shaped-beam cathode ray tube and its associated electronic equipment.

Grossbohlin joined Stromberg-Carlson-San Diego this year as an assistant in the department he now heads. He formerly was in charge of a product development department for the Allen B. DuMont Laboratories in Clifton, N. J.

From 1946 to 1950 Peterson was an instructor in electronics engineering at the University of Wisconsin. Prior to joining Stromberg-Carlson-San Diego, he was a supervisory engineer on computer display test equipment at Hazeltine Electronics Corp. in Little Neck, L. I.

▶ **Automation** — Jack Rosenberg has been appointed manager of automation for Electronic Control Systems, affiliate of Stromberg-Carlson.

He will be responsible for the design, development and prototype construction of high-speed special purpose digital computers and controls for machine tools.

In 1947 Rosenberg joined the

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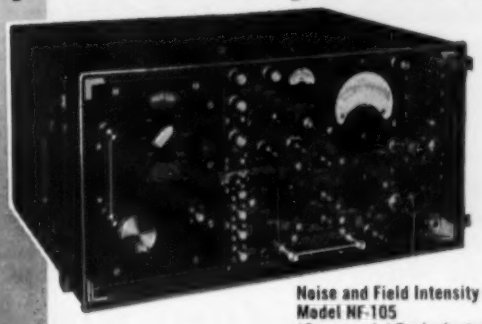

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Model NF-105
(Commercial Equivalent of AN/URM-7)

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150 KC-20MC

T1/NF-105:
20-200MC

T2/NF-105:
200-400MC

T3/NF-105:
400-1000MC

Empire Devices Noise and Field Intensity Meter Model NF-105 permits measurements of RF interference and field intensity over the entire frequency range from 150 kilocycles to 1000 megacycles. It is merely necessary to select one of four individual plug-in tuning units, depending on the frequency range desired. Tuning units are readily interchangeable...can be used with all Empire Devices Noise and Field Intensity Meters Model NF-105 now in the field.

Each of the four separate tuning units employs at least one RF amplifier stage with tuned input. Calibration for noise measurements is easily accomplished by means of the built-in impulse noise calibrator. With this instrument costly repetition of components common to all frequency ranges is eliminated because only the tuners need be changed. The same components...indicating circuits, calibrators, RF attenuators, detectors and audio amplifier... and power supplies...are used at all times.

Noise and Field Intensity Meter Model NF-105 is accurate and versatile, it may be used for measuring field intensity, RF interference, or as an ultra-sensitive VTVM. A complete line of accessories is available.

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In addition, various settings and cushioning methods — silicon rubber, spring, or friction settings — provide maximum protection for bearings subject to severe shock conditions, yet permit controlled jewel movement, thus ending lost time for tear-down and readjustment.

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SAPPHIRE AND GLASS JEWELS, PRECISION GLASS GRINDING, JEWEL MOUNTING AND ASSEMBLY, SAPPHIRE STYLII
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electronic computer project at the Institute for Advanced Study in Princeton, N. J., as a design engineer.

In 1951 he went to the electronics laboratory of GE in Syracuse, N. Y., where he was engaged in the design of specialized military electronic equipment. He remained in that position until joining Electronic Control Systems, Inc., in 1954.

IRE Names 1957 Officer Candidates

NOMINEES for the positions of president and vice-president of the IRE for 1957 are John T. Henderson and Yasujiro Niwa, respectively.

Henderson is principal research officer of the National Research Council in Ottawa, Canada. He has been a member of the IRE board of directors, 1953-1956. He has served on the IRE appointments committee, nominations committee, policy advisory committee and professional groups committee. He has been vice-chairman and chairman of the Ottawa section of IRE.

Niwa is president of the Tokyo Electrical Engineering College of Tokyo, Japan.

American Broadcasting And Western Union Buy

THE American Broadcasting-Paramount Theatres Inc., and the Western Union Telegraph Company purchased a 50 per cent interest in the Wind Tunnel Instrument Co. of Newton, Mass.

The two companies will each receive 33,950 shares of Wind Tunnel stock, under the terms of the transaction, which involves more than $400,000. The balance of the stock is being held by officers and employees of Wind Tunnel.

Organized in 1949, Wind Tunnel Instrument is an aeronautical-instrument-producing concern. It also provides research and development services.

The cash provided by American Broadcasting and Western Union will go toward a capital expansion

program of Wind Tunnel, which plans to build a plant adjacent to Microwave Associates, Inc. and Technical Operations Inc., firms in which AB-PT and WU have a financial interest.

Microwave Associates of Boston and Technical Operations of Arlington, Mass. have formed a new, jointly owned company, Power Sources. The new corporation will produce all-semiconductor power supplies.

The new corporation is directed by Marvin G. Schorr, also vice-president of Technical Operations. The treasurer is Vessarios Chigas, executive vice-president of Microwave. In addition to the above, directors include Dana W. Atchley, Jr., president of Microwave Associates and Robert Smyth, chief electronic engineer of Technical Operations.

Audio Society Elects Officers

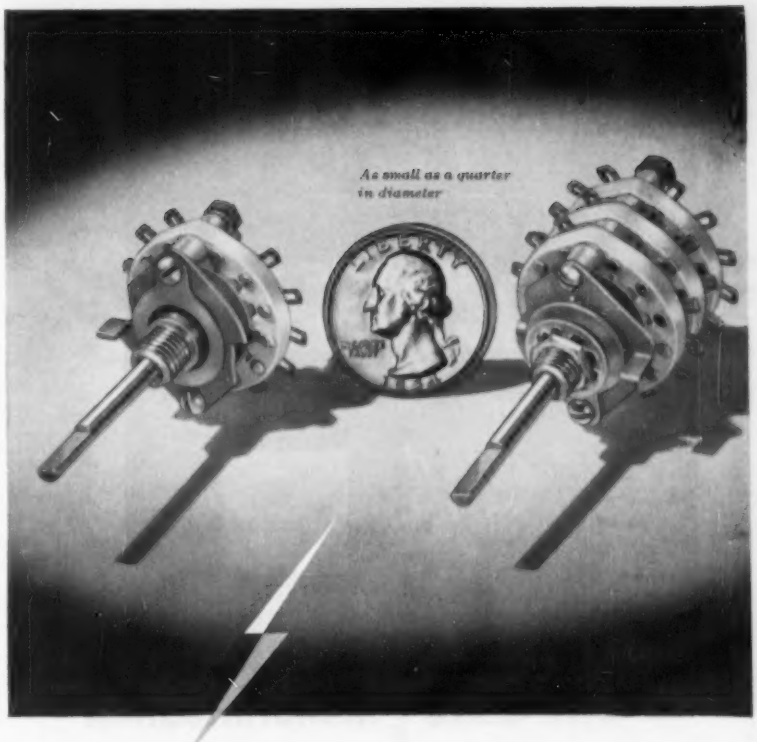
WALTER O. STANTON, president of Pickering & Co. of Oceanside, N. Y., has been elected president of the

Walter O. Stanton

Audio Engineering Society. He succeeds Col. Richard H. Ranger, president of Rangertone in Newark, N. J.

The new president joined Pickering in 1948. He has been responsible for components and systems development in the fields of industrial control, fire control and audio.

Beside being a member of the Society, which elected him executive vice-president last year, Stan-



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- Sections are ceramic — Centralab Grade L-5 Steatite. Wafers can be stacked up three sections per shaft.
- Meets the corrosion-resistance requirements — and exceeds the insulation resistance — specified by MIL-S-3786.

Write for Technical Bulletin EP-73 for complete engineering data.

P-2756

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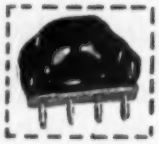

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ton is secretary of the Institute of High Fidelity Manufacturers.

Sherman M. Fairchild, president of Fairchild Recording Equipment Co. in New York, was elected executive vice-president of the Society. Two vice-presidents were chosen: Henry J. Shroeder, president of Shroeder Sales Co., Cleveland, who is central vice-president, and Ross H. Snyder, manager of the custom products department of Ampex Corp. in Redwood City, Calif., who was chosen western vice-president.

C. J. LeBel, chief engineer of Audio Instrument Co. of New York, a founder and first president of the Society, was reelected secretary for his sixth consecutive term. The treasurer, Ralph A. Schlegel, technical facilities supervisor of RKO-General Teleradio Pictures, WOR Division, New York, was also renamed.

Elected as governors were: E. V. B. Kettleman, engineer, recording department, RCA Victor records division of RCA; Len Frank, partner, Carnegie Hall Recording Co. and Clair D. Krepps, technical director, MGM Records.

The Society is a professional organization in the field of recording, transmission and reproduction of sound, in frequencies audible to the human ear. It was formed in 1948 to advance the theory and practice of audio engineering and its allied arts.

Sylvania Opens Two Plants, Selects Engineers

SYLVANIA ELECTRIC formally opened its new electronics plant at Hillsboro, N. H. for manufacture of transistors and diodes.

Built in 1954 and acquired by Sylvania this spring, the Hillsboro plant is a one-story facility with more than 27,000 sq ft of floor space, and is located on a 9-acre site.

Elmer J. Perry is the Hillsboro plant superintendent. There are now 150 employees at the facility, and by the first of 1957 there should be 300 to 350 employees.

Construction has started on a new engineering and pilot production building for the tungsten and

chemical division of Sylvania.

The new 48,000 sq ft building will house engineering offices, laboratories, and pilot plant facilities for more than 100 scientists, engineers, and technicians.

To be completed by the middle of 1957, the building will be used for the division's activity in semiconductors, phosphors, chemicals and metallurgy. With the addition of a new facility, the division's operations will occupy more than 300,000 sq ft of space.

Sylvania also announced that Gordon L. Fullerton has been appointed to the newly created post of manufacturing manager of three television picture tube plants. Since 1954 he has served as plant manager of the Ottawa, Ohio and Fullerton, Calif. plants. The Hatboro, Pa. plant now comes under his direction.

He joined Sylvania as an industrial engineer in 1943 after employment with the A&P Tea Co., and the Pennsylvania Electric Co.

Meisling Joins Stanford Research

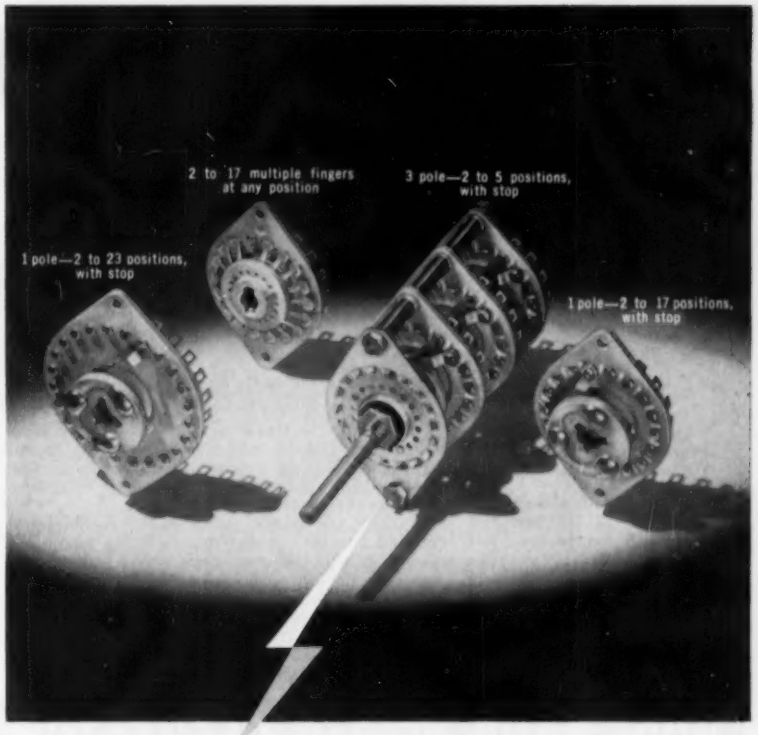
TORBEN H. MEISLING, formerly with the Lincoln Laboratory at MIT, has joined Stanford Research Institute as a senior research engineer in the computer laboratory.

Dr. Meisling was in charge of transistor procurement, testing and circuits theory at the Lincoln Laboratory. Prior to this, he was an assistant professor in digital computer design, and a lecturer and research engineer on computer projects at the University of California.

Automatic Electric Enlarges New Plant

AUTOMATIC ELECTRIC'S manufacturing and research plant, under construction in Northlake, Ill., is being increased by approximately 200,000 sq ft, bringing the over all floor area to more than 1.5-million sq ft.

The increase was required to provide productive capacity in line with revised estimates of the expected demand for dial telephone, communications equipment, auto-


2 to 17 multiple fingers at any position
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- Wafers can be stacked up to 20 sections per switch.
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- Smooth-operating, roller-bearing index insures minimum of 25,000 operating cycles.
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Write for Technical Bulletin EP-74, for complete engineering data.

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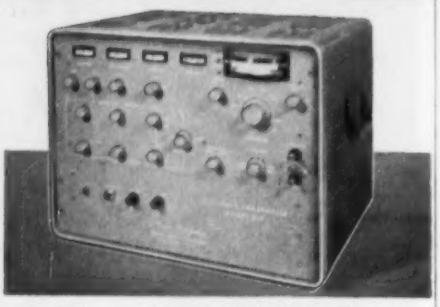

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The instrument measures phase difference between two sinusoidal voltages; phase angles are read from a two-degree, step control with vernier indicator having a precision of 0.01°. Built-in sensing provides direct reading of proper quadrant. Accuracy is independent of even harmonics and of third harmonics up to 1%. Input-level range is from 0.5 to 10 volts rms.

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40 watts at 200-400 mc
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Provides exceptionally broad frequency coverage and substantial power output in a single source. Offers smooth tuning and precise resettability, with overlapping coverage of the full range in two bands.

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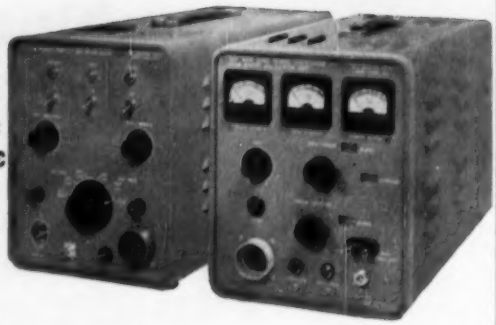

Frequency ranges....200 to 1050 mc, 950 to 2500 mc
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mation devices and other electronic products, according to the company.

More than 7,200 persons now working in 16 separate buildings in the company's existing Chicago plant will be employed in the new building, where all manufacturing operations will be on one floor.

Research and development laboratories and the general, administrative, engineering and sales offices will be housed in a two-story structure adjoining the factory building.

Standard Crystal Elects New Officers

Kenneth B. Thomson

CONTROL of Standard Crystal Co. of Kansas City, Mo., manufacturer of frequency control units, has been transferred to a local group headed by Eugene M. Strauss, insurance executive. The firm has been recapitalized and a board of directors elected by the new stockholders. New company officers are: Kenneth B. Thomson, president; Ernest O. Ruff, vice-president; Alan K. Benjamin, secretary and Eugene M. Strauss, treasurer.

Standard Crystal will continue to manufacture low-frequency crystals as well as the more standard types of frequency control units.

Thomson has been associated with crystal manufacturing for fifteen years. He was formerly president of American Crystal Co. and has in the past been connected with Bliley Electric Co., Sherold Crystals, and Export Sales Co. Ruff, the new vice-president, continues in his previous post of chief engineer to the company; he was for-

merly chief of engineering development for American Crystal. Strauss is president of Gene Strauss & Associates, Inc., an insurance firm headquartered in Kansas City. He is also a director of Westpan Hydrocarbon Company of Amarillo, Texas and Kansas City.

Perkin-Elmer Appoints Borden

JOSEPH L. BORDEN has been appointed head of the infrared instrument development section of the engineering & optical division of Perkin-Elmer Corp. He will be concerned, primarily, with the development of infrared reconnaissance instruments.

He joined the firm in 1949 and worked initially on the development of bombing systems for high speed aircraft. In 1952 he joined the company's infrared process control analyzer program and, prior to his new appointment, had been responsible for the application engineering and sales of the process control instruments.

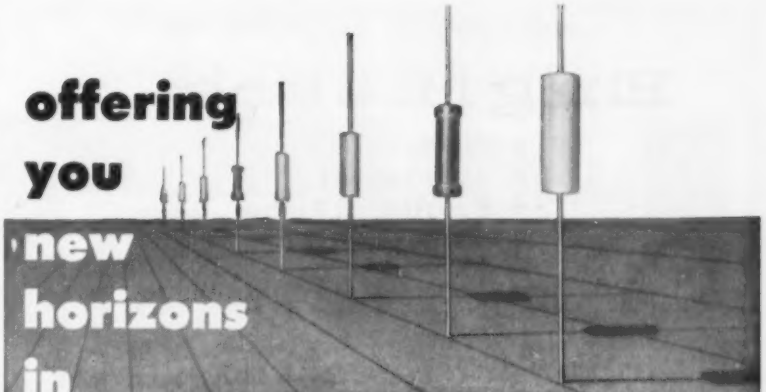
Before joining Perkins-Elmer, Borden was associated with the Servo Corporation of America and with the Glenn L. Martin Co.

Franklin Institute Honors Firestone

FLOYD A. FIRESTONE, an educator, will be recipient of the Edward Longstreth Medal of The Franklin Institute of the State of Pennsylvania. The award will be made at the Institute's Annual Medal Day ceremonies.

The Institute is recognizing Dr. Firestone "For his invention and development of a practical industrial tool for the detection and measurement of the location and extent of defects in metal parts by ultrasonic means," namely the ultrasonic reflectoscope. He taught at the University of Michigan until 1945 where he was an assistant and associate professor of physics. Since 1945 he has been a consulting physicist.

The holder of over 25 patents, Dr. Firestone applied for patents on the ultrasonic reflectoscope in 1940. To his credit also are patents on a



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Bendix Division Appoint Engineer

RALPH A. LAMM has been appointed director of engineering for the Pacific division of Bendix Aviation Corp.

Until recently Lamm was head of special missile development at the Bendix research laboratories division. He joined the corporation staff in 1955.

Lamm has been staff member of the Radiation Laboratory of MIT; head of the MIT field experimental station in Washington, D. C.; chief of the missiles division of the National Bureau of Standards; and assistant director and chief of the missile division of the Corona Labs.

Hughes Names Lab Head

FRANK G. MILLER has been appointed head of the engineering laboratory of the Hughes Aircraft guided missile laboratories in Tucson, Ariz.

Until his recent appointment, he was head of the systems engineering department of Hughes' guided missile laboratories in Culver City, Calif.

Before joining Hughes in 1950, Dr. Miller was engaged in microwave circuit development at GE and later associated with the Naval Research Laboratory. At Hughes he worked in guidance and control development.

Haydu Brothers Re-establish Company

GEORGE AND ZOLTON HAYDU have formed a new company, Haydu Electronic Products. George Haydu has been appointed president. The company has purchased certain assets and manufacturing equipment, including complete machine products division, tool and die division and electronic components manu-

facturing division, from Haydu Brothers of New Jersey, subsidiary of Burroughs Corp.

The new company will continue to manufacture electronic components and equipment. In addition, they will continue the production of precision burners for the electronic tube and glass working industries. Plans have already been made and a program set up towards expansion into such diversified fields as instrumentation, automation and consumer products.

The company has a new plant in Plainfield, N. J.

GE Locates TEMPO, Appoints Engineers

SANTA BARBARA, CALIF. was selected by General Electric as headquarters for its new defense electronics planning operation.

It will be known as the technical military planning operation, TEMPO, and be a part of the company's defense electronics division. Broad objectives of TEMPO will be to assure the United State of technological leadership in weapons systems and to provide maximum defense per dollar in these systems.

The new operation will have its headquarters temporarily in leased space and is planning a permanent facility.

R. C. Raymond, manager of the new operation, said TEMPO is now recruiting a staff of scientific and engineering personnel and that current plans call for an organization of 50 professional and administrative employees by the end of 1956 and another 50 in 1957.

Dr. Raymond is a former head of the electronics department of the Rand Corp. at Santa Monica, Calif.

Peter J. Schenk is manager of TEMPO's projects section and Russel L. Krapf is manager of the finance and administrative section.

Because TEMPO is essentially an advance planning organization, no laboratory or manufacturing facilities are planned at Santa Barbara. However, facilities for computation and other tasks associated with advanced study programs will be installed as needed.

TEMPO will do advanced tech-

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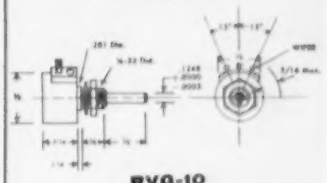
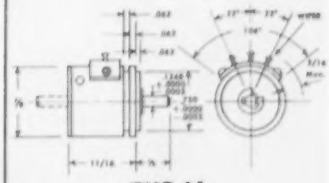
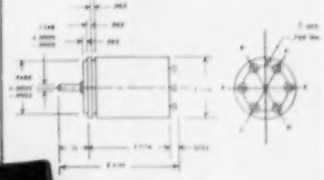

RVG-10


RVG-14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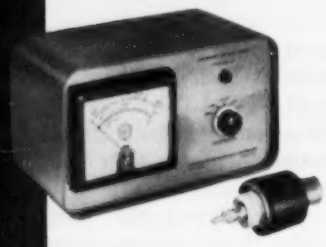

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nical planning and study work for the company's defense electronics division and its product departments, and for outside customers when projects are beyond the scope of any one of these departments.

The new operation also will be responsible for marketing advanced complex weapons systems of its own creation as well as for systems which are required by customers but which are beyond the scope of any one of the division's product departments.

▶ **Appointments**—Henry F. DeLong has been appointed general manager of GE's cathode ray tube department.

Since 1952 he has been manager of manufacturing in incandescent lamp operations in Ohio.

In his new position, he will direct operations of the cathode ray tube department which has plants in Syracuse and in Buffalo, N. Y. DeLong joined the company's chemical products department at Nela Park, Cleveland, in 1934 and later transferred to the standardizing division.

Henry F. DeLong

Raymond J. Barclay was appointed manager of manufacturing for the GE industrial computer section.

In his new position, he will be responsible for the manufacture of the company's complete line of analog and digital computers. He was formerly a manufacturing specialist for industrial computers. He joined the company in 1942. GE recently expanded its industrial

computer section sales force into a national organization with headquarters in Syracuse.

George C. Trotter, manager of sales for the section, said the present industry-wide computer sales of $450 million annually will increase to more than one-billion dollars by 1965. The new sales organization is designed to increase significantly the firm's sales effort in this growing market.

The sales-force merger includes appointments of five key sales managers in specialized computer fields, such as military, banking and finance, transportation and industrial control.

Lear Selects Department Head

DALLAS V. FRANKE has been named head of a new engineering department at the LearCal division of Lear in Santa Monica, Calif.

The new advanced development department has been established to expand activities in system development, studies, and analyses. Currently the department has study and development programs in the fields of electronic counter-measures, navigation, and the self-correcting automatic navigation (SCAN) system.

Franke until recently was research director and sales manager of Cal-Tronics. Previously he held positions of chief engineer at American Electronics, research engineer at Hughes Aircraft, and senior engineer at Gilfillan.

Karp And Lesser Form New Firm

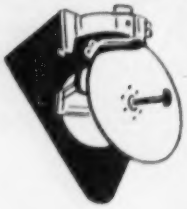
DANIEL S. KARP and John Lesser, formerly chief executive officers of Karp Metal Products Co. in Brooklyn, N. Y., have formed Karp, Lesser & Co., in New York, N. Y., serving as engineering and management consultants to the precision sheet metal fabrication field and allied industries.

Karp, former president of Karp Metal Products Co., was also vice-president and a director of H & B American Machine Co.

Prior to his service with Karp

JOSEPH D. SCHANTZ
Chief Electronics Engineer

RADAR SPECIALIST



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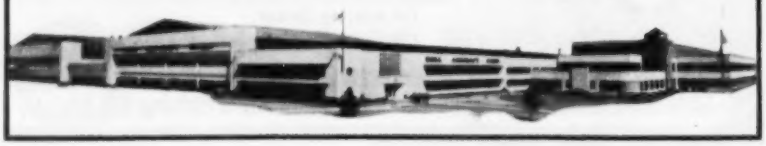

Metal Products as assistant chief executive officer, Lesser was vice-president and general manager of Photo Chemical Products of California.

Also associated with Karp and Lesser is William G. Lampe, who for twenty-five years served with Karp Metal Products Co. as plant superintendent and chief engineer.

ACF Establishes Missiles Group

ACF INDUSTRIES has established a missiles group to coordinate the activities of its several divisions in the field of missiles and related weapons systems.

Function of the new group is to assemble the divisions' component

Richard F. Wehrlin

skills and apply them to over-all weapons systems.

Richard F. Wehrlin, president of ACF's Avion division, was named chairman of the missiles group.

Gen. C. L. Bolte (Ret.), former U.S. Army vice-chief of staff and now special assistant to ACF's board chairman, was named assistant chairman. Other members are top executives of the several divisions and of the parent company in New York.

Dalmo Victor Moves To New Plant

DALMO VICTOR CO. began its move into a new $1.5 million plant in Belmont, Calif.

All offices and production lines, formerly housed in six separate

buildings in the San Carlos-Belmont area, will be consolidated in the new structure containing 180,000 sq ft of floor space.

Dalmo Victor Co., manufacturer of aircraft radar antennas and other airborne equipment, was founded in 1921 in San Francisco by T. I. Moseley, who continues as president. In 1954 the company became a division of Textron of Providence, R. I.

Harmon-Kardon Expands Facilities

HARMAN-KARDON acquired an additional plant adjacent to their present location in Westbury, L.I., N. Y.

The new building will house new automation production equipment to be used in the manufacturing of printed circuit high fidelity tuners, amplifiers, and combined receivers. The additional area will double production facilities.

Martin Names Electronic Engineer

CECIL O. RIGGS has joined the Glenn L. Martin Co. in Baltimore, Md., as a senior electronic engineer. He has been head of the physics department of Waynesburg College since 1946, and from 1921 to 1942. During the war he taught in the electrical engineering department of the United States Naval Academy.

Lockheed Begins Move To New Labs

LOCKHEED'S missile systems division began moving into its multimillion dollar research laboratories in Palo Alto, Calif.

The initial movement of some 100 employees into the $4 million research laboratories is the start of a gradual transfer to the Bay area of approximately 400 people from the missile division's present Van Nuys, Calif. plant. Transfers to the research facilities will bring the total number to 600 in October.

Activation of the laboratories, located on a 22 acre site in Stanford University's industrial park, marks the completion of the first phase of the company's Bay area building

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POTENTIOMETERS
keep moisture, dust, and price in line

Once you use these Model H-MS Potentiometers, you'll see why it pays to call upon CIRCUIT INSTRUMENTS for all your requirements. CIRCUIT INSTRUMENTS is big enough to engineer the latest refinements in potentiometers. But it is small enough to keep production procedures highly flexible. This means greater ease in obtaining special features . . . greater assurance of obtaining quick deliveries.

MODEL H-750-MS POTENTIOMETER (actual size)

EFFECTIVE SEALING . . .
The next best thing to hermetic sealing. Model H-MS more than meets JAN-R-19 moisture and humidity requirements. Its all-metal case is rolled and securely bonded at the joints. Terminals are glass sealed. The shaft is sealed by means of an "O" ring.

WIDE CHOICE . . .
Model H-MS is yours in ¾", 1" or 1½" standard case sizes . . . in 1, 5 or 10 turn design . . . with resistance values from 50 to 400,000 ohms . . . with a wide spread of tolerances . . . in 2 or 3 watts or higher . . . with many special features.

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TACHOMETER GENERATOR

permanent-magnet

APPLICATIONS

- **VELOCITY SERVOS** Ideal for use as a rate generator in servo or integrating devices where a highly linear speed/voltage relationship is required with minimum ripple.
- **DIRECT READING TACHOMETER** Makes an excellent tachometer when combined with a d-c voltmeter having proper voltage range.
- **SPEED TRANSDUCER** Ideal for use as a speed transducer in connection with fast response direct writing oscillographs.

FEATURES

- **SIZE** Miniature. Approx. dia. 1¼".
- **LINEARITY** Output voltage is proportional to speed to better than ½ of 1%.
- **SPEED** Excellent service life at 12,000 rpm. Higher speeds possible.
- **OUTPUT** Various models up to 20 volts per 1,000 rpm.
- **RIPPLE** The rms value will not exceed 3% of the d-c value at any speed in excess of 100 rpm.
- **BRUSH LIFE** Better than 20,000 hours at 1800 rpm.
- **BIDIRECTIONAL OPERATION** Output in either direction is held to a ¼ of 1% tolerance.
- **CONSTRUCTION** Aluminum housings with protective treatment; stainless steel shafts; fully shielded ball bearings; Mylar insulation.

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program. The recently-completed research facilities includes two main laboratories of 51,000 sq ft each. Now being completed is a 14,000 sq ft laboratory building.

IBM Selects Research Director

Emanuel R. Poire

EMANUEL R. PIORE has joined IBM as director of research.

Dr. Piore was formerly chief scientist of the Office of Naval Research. His most recent post was research vice-president for Avco Manufacturing Corp. where he was engaged mainly in the direction of scientific programs. He remains a consultant for that firm.

At IBM, he will head a company-wide research effort presently being carried on in laboratories located in New York and California and in Zurich, Switzerland.

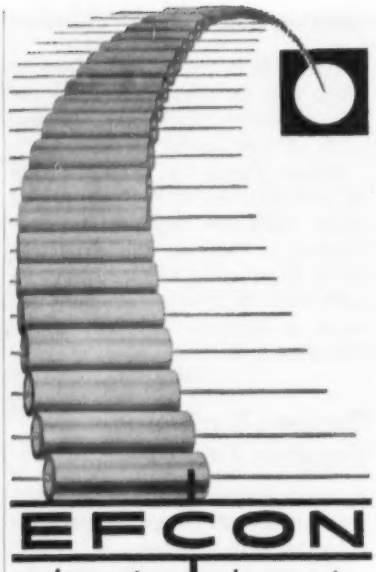
While with the Office of Naval Research, he was instrumental in helping the government in the use of general-purpose digital computers and in developing programs in applied mathematic and numerical analysis.

In 1935, he joined RCA, later moving to CBS as engineer-in-charge of the television laboratories. He is associated with some of the early work on color tv.

Honeywell Buys Plant For Transistors

MINNEAPOLIS - HONEYWELL purchased the Hathaway plant in Boston, Mass.

The three-story, 250,000-sq-ft plant will house Honeywell's transistor division—engineering, production and sales—that is scheduled for transfer to the Boston area



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Only EFCON mass-produces miniature plastic film capacitors to close tolerances.

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EFCON Mylar* and Polystyrene Film Capacitors are each available in two styles: Types MC and PC have a rigid cardboard tube construction; Types MH and PH are hermetically sealed in a metal case with glass-to-metal, solder-sealed terminals. Extended foil construction with leads directly soldered to the foil minimizes inductance and contact resistance for all types.

The plastic film ensures high insulation resistance, low dielectric absorption and stability over extended temperatures and life. Types MC, PC, MH and PH capacitors are available in a range of standard capacitance values from 0.001 to 2 mfd. Non-standard values and tolerances closer than ±1% are obtainable to your specifications.

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Type S Molded Silver Mica Capacitors

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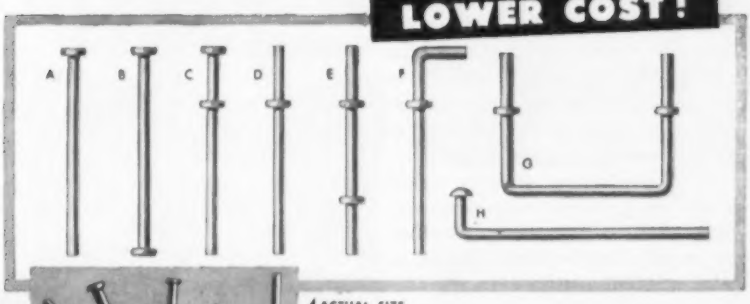

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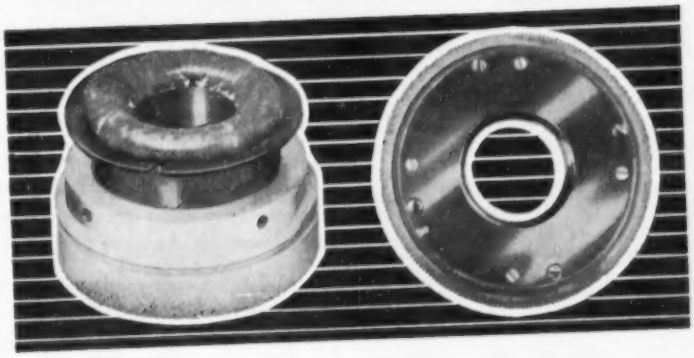

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VIBRATION . . . 5 to 25 cps @ 0.4" peak to peak excursion; 25 to 2000 cps @ 20G acceleration; No contact opening, relay energized or de-energized.

SHOCK ELECTRICAL . . . 75G for 10 milliseconds minimum. No contact opening, relay energized or de-energized.

SHOCK MECHANICAL . . . 200G minimum . . . no physical damage to relay or change in electrical characteristics.

Models 2A and 4A are subminiature, hermetically sealed, D.C. relays which meet and in several respects exceed the requirements of MIL-R-5757B. They are actuated by a "balanced-armature" rotary motor. Both models are particularly suited to dry-circuit switching applications.

LEADING PARTICULARS

Ambient Temp.:	—65°C to +125°C
Weight:	3.2 oz. maximum
Height of Case:	1½" maximum
Diameter of Case:	1 3/32" maximum
Terminals:	Flattened & pierced
Contact Arrangement:	DPDT — Model 2A 4PDT — Model 4A
Contact Material:	Fine silver to molybdenum
Operation:	Simultaneous operation, simultaneous release, no contact bounce
Pull-in-power (Coil):	⅜ watt — Model 2A ½ watt — Model 4A

Test Data and Literature on Request

Built-in Dependability

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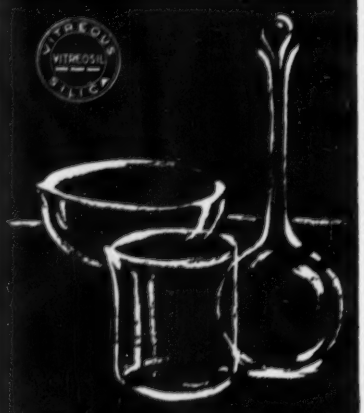

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from its present location in Minneapolis. The activities and administration will be integrated with those of the firm's Doelcam division, also located in Boston. Production facilities for manufacture of the Doelcam division's line of gyroscopes, synchro motors, and other precision electro-mechanical servo components will also be consolidated in the new plant.

The plant would ultimately employ 1,500 people. Approximately 600 of these will be new jobs, the remainder being transfers of key engineering personnel from the transistor operations in Minneapolis and some production and supervisory employes from the Doelcam plants.

The new facilities are expected to be in production by mid-December, 1956.

IRC Relocates Subsidiary Plant

CIRCUIT INSTRUMENTS, a subsidiary of International Resistance Co., moved to a new plant in St. Petersburg, Fla.

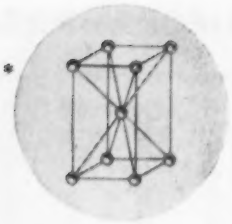
The 12,500 sq ft building permits expansion of laboratories, model-shop, engineering and design departments. It will more than quadruple available production facilities.

At present 85 people are employed. It is expected that 200 to 250 will eventually be required.

International Resistance Company is located in Philadelphia,

New Circuit Instruments plant

with branch plants in Downingtown, Pa., Asheville and Boone, N. C. and Burlington, Ia. Hycor,



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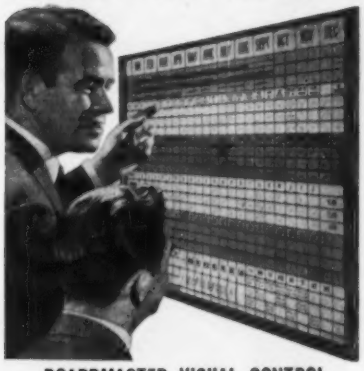

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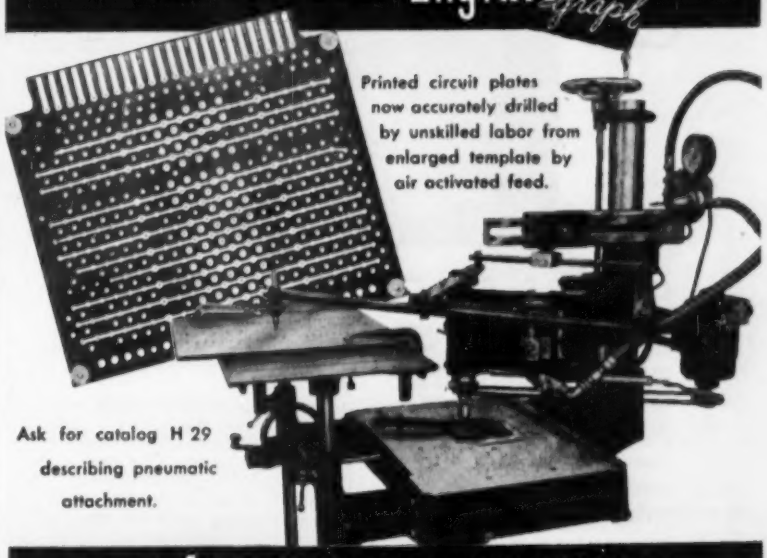

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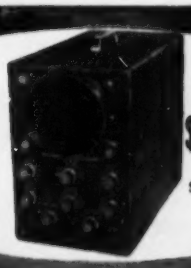

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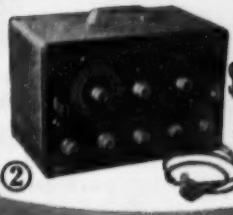
① Check the outstanding engineering design of this modern *printed circuit* Scope. Designed for color TV work, ideal for critical Laboratory applications. Frequency response essentially flat from 5 cycles to 5 Mc down only 1½ db at 3.58 Mc (TV color burst sync frequency). Down only 5 db at 5 Mc. New sweep generator 20-500,000 cycles, 3 *times* the range usually offered. Will sync wave form display up to 5 Mc and better. Printed circuit boards stabilize performance specifications and cut assembly time in half. Formerly available only in costly Lab type Scope. Features horizontal trace expansion for observation of pulse detail — retrace blanking amplifier — voltage regulated power supply — 3 step frequency compensated vertical input — low capacity nylon bushings on panel terminals — plus a host of other fine features. Combines peak performance and fine engineering features with low kit cost!



MODEL TS-4 $49.50 Shpg. Wt. 16 lbs.

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SWEEP GENERATOR KIT
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② A new Heathkit sweep generator covering all frequencies encountered in TV service work (color or monochrome). FM frequencies too! 4 Mc — 220 Mc on fundamentals, harmonics up to 880 Mc. Smoothly controllable all-electronic sweep system. Nothing mechanical to vibrate or wear out. Crystal controlled 4.5 Mc fixed marker and separate variable marker 19-60 Mc on fundamentals and 57-180 Mc on calibrated harmonics. Plug-in crystal included. Blanking and phasing controls — automatic constant amplitude output circuit — efficient attenuation — maximum RF output well over .1 volt — vastly improved linearity. Easily your best buy in sweep generators.

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a division of IRC, is located in Sylmar, Calif. Another subsidiary, Hycor Co., is in Vega Baja, Puerto Rico. The company has licensees in Argentina, Australia, Canada, Denmark, England, Germany, Italy and Japan, as well as a wholly-owned plant in England.

Farnsworth President Joins Litton

Harvard L. Hull

HARVARD L. HULL has joined Litton Industries as a vice-president. Dr. Hull leaves his post as president of the Farnsworth Electronics Co. a division of IT&T.

Active in various executive management positions for the Manhattan Project and the Argonne National Laboratory in the field of atomic energy during the period 1943 to 1953, Dr. Hull was made a vice-president for research and development for Capehart-Farnsworth in 1953. A year later he was appointed president of the company.

He joined the Sperry Gyroscope Co. in 1933 to do research and development work in military and industrial electronics, a field in which he has been active ever since. He remained with Sperry until 1943 when he was named director of process improvement for the Tennessee Eastman Corp.

Gabriel Fills Engineering Post

HENRY G. GIULIANI has been appointed to the newly created post of assistant to the director of engi-

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Components can be built from your prints or can be designed and built to integrate with the application. Close and confidential coordination is maintained from drawing board stage to installation.

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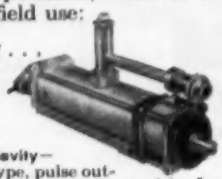

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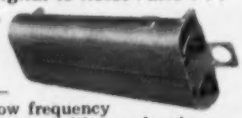

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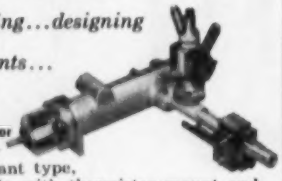

S-Band Signal Generator Cavity— re-entrant type, complete with thermistor mount and calibrated variable attenuator. Frequency range 2700 to 3400 mc.

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neering and sales for the Gabriel electronics division of The Gabriel Co.

He has served as chief engineer at the E. A. Rockwell Laboratory, assistant director of research for Tidewater Oil Co., president and chief engineer of Aero Units, and chief mechanical engineer of Lavoie Laboratories.

Planet Doubles Production Capacity

PLANET MANUFACTURING CORP., manufacturer of capacitors in Bloomfield, N. J., has completed construction of a new building adjoining the present plant.

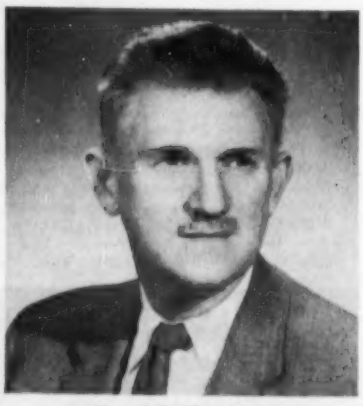
The new facility, in addition to housing new offices and a laboratory, doubles the company's 1955 production capacity and represents over four times the capacity with which the company started in 1949.

The additional capacity is being devoted exclusively to the manufacture of electrolytic capacitors.

Airborne Instruments Enters Computer Field

AIRBORNE INSTRUMENTS LABORATORY of Mineola, N. Y. acquired Mountain Systems, Inc. of Thornwood, N. Y.

Mountain Systems will be operated as a separate and wholly owned affiliate of Airborne, with a board of directors consisting of Hector R. Skifter, John N. Dyer, Donald M. Miller (three of Air-



Joseph D. Mountain

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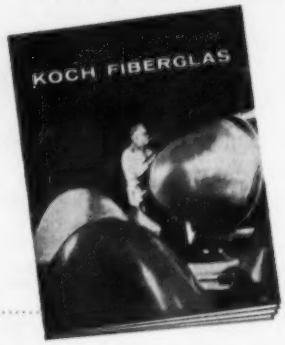

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Koch cases for electronic equipment will not dent, are impervious to moisture, vapor, fungus, mildew and corrosion. They are shock and vibration-proof when fitted to Koch specifications with special hair-latex shock pads. Can be self-palletized for fork lift. Can be insulated by Koch with foamed-in-place plastic. Koch cases are air-tight; require no paint or outer packaging for long-range storage or overseas shipment. Re-usable, so cost amortizes through re-use. Withstand parachute drops from any height, free falls onto water or snow from 500 feet, or submersion.

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For 60 Cycle Use

Built to rigid commercial specifications.

Twenty-two types, both single and double pole.

Long life.

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Extreme reliability.

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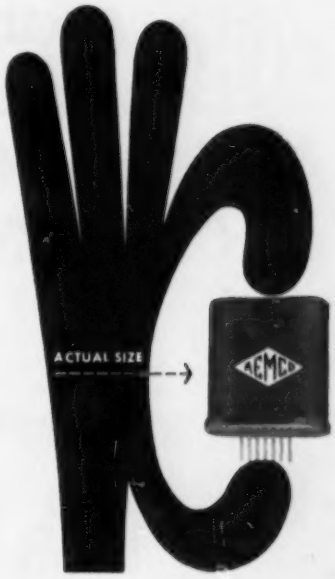


need sub-miniature relays?

AEMCO'S Type 95 Sub-miniature Relay is "first choice" for design engineers working toward miniaturization and modification of existing equipment. Sealed in a tiny crystal case, AEMCO'S 95 relay weighs less than ½ ounce . . . measures only .78" in length! Now available with a wide variety of terminals and mountings, this relay is adaptable to a number of applications previously limited.

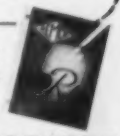
TWO BASIC UNITS AVAILABLE: 95-2029 with DPDT contacts rated at one amp. @ 28 VDC. 95-2267 with either one of two combinations, (SPDT and SPST-N.O. or, SPDT and SPST-N.C.) rated at 0.25 amps @ 28 VDC, permitting design variation to fit most applications.

OTHER RELAY TYPES AVAILABLE

Typical of AEMCO ingenuity, type 95 Sub-miniature Relay is just one unit from AEMCO'S complete relay line. Others are available in a wide choice of spring and coil combinations, operating potentials and contact ratings. If one of the hundreds of AEMCO relay types does not exactly meet your specifications, we will be happy to design and manufacture a unit to meet or exceed your requirements.

AEMCO also manufactures a complete line of SEQUENCE and AUTOMATIC RE-SET TIMERS, TIME SWITCHES, and SIGN FLASHERS.

WRITE TODAY—Your inquiries are invited. Ask for Bulletin "H" which describes the 95 as well as other relays in the complete AEMCO line.



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Regency is in the vanguard of those pushing transistors into the VHF region. This is a real opportunity for the right man to work for a young, forward-looking company that is already out front in the semi-conductor equipment field.

If you are that man send resume to: Edward C. Tudor, President

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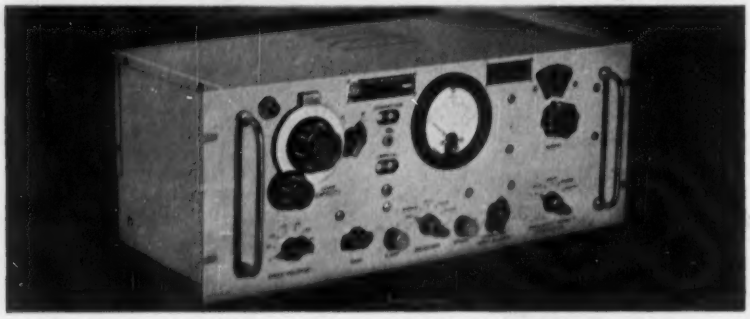
RFL **PRODUCT NEWS**

RADIO FREQUENCY LABORATORIES, INC.

3 Standards for Testing Quartz Crystal Units

These Crystal Impedance Meters will measure resonance and anti-resonance resistance of quartz crystals, including those covered by Spec. MIL-C-3098A. Capacitance, inductance and performance index (PI) of the crystal can be determined from these parameters.



Model 541A (TS-710/TSM)
Frequency Range 10-1100 kcs.

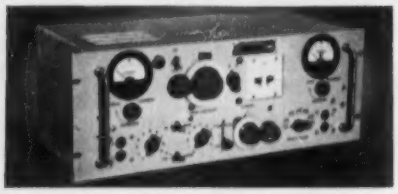
Measures the effective resistance from 200 ohms to 0.5 megohms, over five frequency bands, of crystal units. An internal load capacitance is calibrated from 15 to 105 mmf. with an accuracy better than ±0.5 mmf. Power dissipated in the crystal unit is accurately measured by a self-contained VTVM and ohmmeter. Operates from regular 115/230 volt, 50/1000 cps. power source.

Accessories include 14 fixed and 3 variable calibrating resistors and adapters for octal base and HC-5/U crystal unit holders. Net price $650.

Model 531 (TS-683/TSM)
Frequency Range 10-140 mcs.

Twelve fixed calibrating resistors of 10, 22, 30, 40, 51, 60, 68, 82, 91, 100, 120 and 150 ohms, plus a 100-ohm variable resistor are used to determine the effective crystal unit resistance. An anti-resonance adapter with a fixed load capacitance of 32 mmf. is also provided. Fits standard 19″ wide relay rack. Operates from regular 115/230 volt, 50/1000 cps. power source. Net price $550.

All three models are identical in finish and overall size; front panels measure 7 x 19. Loop type handles are mounted on each side of panel for convenient handling.



Hundreds of these C.I. Meters built by RFL are in service throughout the world. They can be relied upon for accurate, extended performance. All models are in current production.

Model 459 (TS-330/TSM)
Frequency Range 1-15 mcs.

This C.I. Meter was the first model produced for the Signal Corps under the national crystal testing standardization program and is still filling a current need.

Four built-in resistance decades cover 0-9900 ohms in ranges of 0-99, 0-990 and 0-9900 ohms. The internal load capacitor is calibrated from 12 to 110 mmf. with an accuracy better than ±0.5 mmf. Net price $560.

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borne's principal officers) and Joseph D. Mountain. The principal officers of the newly formed group are Joseph D. Mountain, president; John N. Dyer, vice-president; and William H. Dobbins, secretary and treasurer.

Mountain Systems is in the field of research, development, and manufacture of business data equipment.

Airborne is in the electronic fields of radar and navigation, air-traffic control, medical diagnosis, nuclear technology, special systems and components, countermeasures, and automatic controls.

Wynkoop Elected V-P of RCA

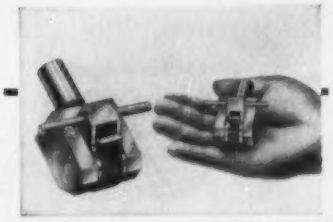
REAR ADMIRAL Thomas P. Wynkoop, Jr., U.S.N. (ret.) was elected

Thomas P. Wynkoop, Jr.

vice-president, commercial marine distribution for RCA.

Since 1949 he has been president of Radiomarine Corp. of America, a subsidiary which was recently merged into RCA. Radiomarine's communications, manufacturing, marketing and service functions have been transferred to other RCA units. Admiral Wynkoop will be responsible for the coordination of commercial marine distribution activities throughout the corporation.

He joined RCA upon his retirement from the Navy where his assignments included eight years in the Navy Department in Washington, and duty in some of the Navy's



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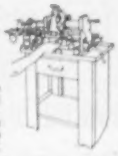

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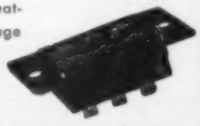

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largest shipyards. He was commander of the Naval Shipyard, Long Beach, Calif., from 1946 until his retirement from the Navy in 1949.

Farnsworth Appoints Research Director

Charles D. W. Thornton

CHARLES D. W. THORNTON has been appointed director of research of Farnsworth Electronics Co. He came to Farnsworth in 1956 directly from the Atomic Energy Commission in Washington, D. C. He has been acting in the capacity of special assistant to Harvard L. Hull, president, on atomic energy. In his new assignment, he will be responsible for work in the areas of solid state physics, storage and experimental tubes, nuclear instrumentation, applied physics, and will act as scientific advisor to the vice-president of research and development. His last position with AEC, prior to coming to Farnsworth, was director of the general manager's office of operations analysis and planning.

New Electronics Firm Established

A NEW corporation, Mandrel Industries, devoted to manufacture and research in technological fields, has been formed. It consolidates under a single administrative structure three manufacturing firms.

The three divisions of Mandrel consist of the electric sorting machine division, specializing in the

Genisco Rate-of-Turn Tables facilitate fast, precise calibration and evaluation of rate gyros

Ball-disc integrator drive provides infinitely variable rates from 0.01° to 1200°/sec.

EXTREMELY ACCURATE... constancy of angular velocity of the turntable is within 0.1%, including wow and drift errors, at any rate.

SMOOTH, CONSTANT ROTATION... unique synchronous motor, designed specially for this application, has large diameter rotor; high polar inertia.

EASY TO OPERATE... single handwheel controls turntable speed. Inexperienced personnel can operate machine after few minutes instruction.

IDEAL FOR LARGE VOLUME TEST PROGRAMS... ruggedness, simple operation, repeatability, and versatile mounting facilities make it the ideal machine for production-line testing.

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LOW ELECTRICAL NOISE LEVEL... better than −55 dbm per slip ring circuit (zero dbm = 1 mw in 600 Ω).

UNUSUALLY RUGGED... built to take years of continuous use; requires only minimum amount of maintenance.

TABLE CAPACITY... 100 pounds.

ACCESSORIES INCREASE ITS USEFULNESS!

SUB-RANGE ADAPTER... extends low range of Genisco Rate-of-Turn Table to 0.0001° per second.

PRECISION STROBE UNIT... for use in areas where accuracy of line frequency is questionable, or for calibration of gyros with accuracies better than line frequency.

MOUNTING STANDS... available in portable and fixed models.

Send today for complete specifications. Please direct your inquiry to Contracts Manager, Genisco, Incorporated, 2233 Federal Avenue, Los Angeles 64, California.

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Gudebrod Lacing Tapes are easy to tie, easy on the hands. Knots tie securely—stay put!

GUDELACE* . . . the original braided nylon wax-coated lacing tape.

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NEW TEFLACE . . . the latest advance in tapes, coated with DuPont Teflon, to withstand extreme temperature conditions.

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A RELAY that flies with NIKE

15 G UP TO 2000 CPS

Limited quantity of model shop samples available. Submit your specifications and requirements with your inquiry.

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DIMENSIONS
15/32" dia. x 1-3/4" long

WEIGHT
7/8 oz.

OPERATING POWER
500 MW Max. (This relay is available for power requirements as low as 100 MW but with slightly less vibration resistance.)

VIBRATION RESISTANCE
15G up to 2000 CPS

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RELAYS W S LONG BRANCH, N. J.

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Increased operational versatility . . greater accuracy in RF, VHF and UHF SPECTRUM •ANALYSIS

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PANORAMIC PANALYZOR MODEL SB-8b

Check these advanced engineering features:

NEW Continuously variable scanning rate from 1 thru 60 scans/sec with one control. Three selectable modes . . . free running, line synch or external synch.

NEW Three selectable types of amplitude displays . . . Square law exponential Linear 20 db, Log 40 db.

NEW Flat face CRT, edge lit calibrated screen and camera mount bezel for photographic records—optional.

NEW Differential markers to show frequency dispersion available in the Type T-10,000.

The Panalyzor Model SB-8B is available in three types.

Type	Sweepwidth Range	Resolution Range
T-200	200 kc - 0 kc	50 cps - 4.5 kc
T-1,000	1 mc - 0 mc	400 cps - 10 kc
T-10,000	10 mc - 0 mc	9 kc - 100 kc

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Made by the makers of Panadaptor, Panoramic Sonic Analyzer, and Panoramic Ultrasonic Analyzer.

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ATLAS Precisioneers "HUSH-HUSH" Assemblies for THE FALCON

● NO HIDING place "upstairs" for enemy bombers with *The Falcon* on the hunt. This newest guided missile is being produced for the U. S. Air Force by Hughes Aircraft Company.

Some of the "innards" of this bird of prey are ATLAS-Precisioneered and classified "confidential." But there's no secret as to how ATLAS can help you develop parts and assemblies from pilot stage to production efficiency for radar . . . sonar systems . . . computers . . . correctors . . . all types of electro-mechanical devices. Just bring your designs to ATLAS. At your disposal *on a job* basis are our men, equipment, techniques; a prototype is turned over to you for volume production.

When war or peace demands a product, call on ATLAS Precision Products Co. (div. of Prudential Industries), Philadelphia 24, Pa.

Send for booklet, "Precisioneering Electro-mechanical Equipment."

ATLAS *Precision Products*

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manufacture of electronic and pneumatic sorting equipment; The Greenleaf Mfg. division, primarily engaged in research, development and production of aircraft, electronic and ordnance components and equipment; and Electro-Technical Labs. division, manufacturer of geophysical oil exploration equipment. The new corporation will have assets in excess of $4 million.

Electric sorting machine division will continue to operate in its newly-completed plant in Grand Rapids, Mich. The Greenleaf Mfg. division will conduct its principal manufacturing activities in St. Louis, Missouri. Electro-Technical Labs division temporarily occupies headquarters at Houston, Texas pending completion of new facilities in Houston.

Directors of the newly-formed corporation are James R. Lowe, chairman, James F. Coonan, vice-chairman and managing director, George Quist, Louis W. Greenblatt and Alonzo G. Curtiss.

Burroughs Promotes Top Engineers

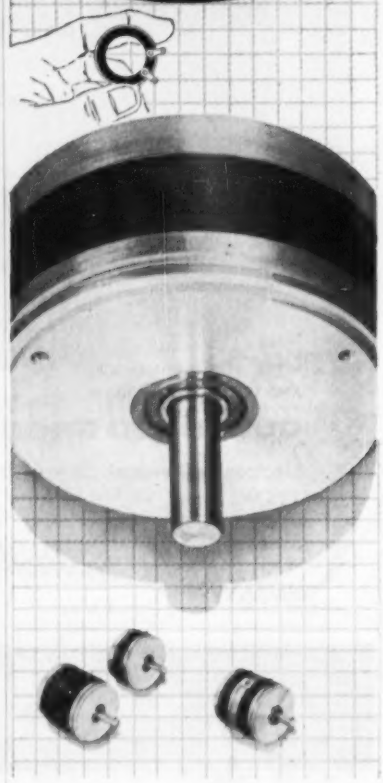
IRVEN TRAVIS, who has been vice-president of research for Burroughs Corp. since 1952, has been named vice-president of research and engineering.

Raymond G. Bower, vice-president of engineering, will retire. He has been associated with the company for 37 years and as vice-president of engineering since 1946.

Dr. Travis joined Burroughs in 1949 as director of research activities at Paoli, Pa. He was made a

Irven Travis

CRITICAL POT SPECS* are met at CIC



Equipment designers who demand more than "shelf item" specifications, rely on CIC for dependable delivery of ultra-precise potentiometers.

The result of CIC research, carbon film potentiometers are setting new standards of accuracy, life at higher speeds and performance reliability.

CIC has assisted many firms in a wide variety of industrial instrumentation, military fire control and flight guidance equipment.

Why not discuss your specific requirements with us?

*New carbon film techniques assure virtually infinite resolution; linearity to .01%, sine-cosine to .025%; compact ganging; precision ball bearing servo construction.

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- For Hangars, Air Fields, Missiles
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15 to 1500 amps

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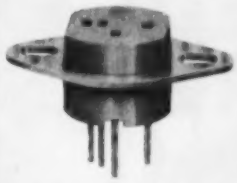
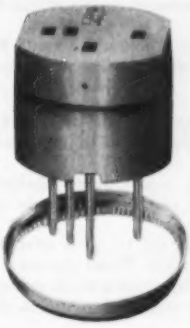
IF IT'S NEW...IF IT'S NEWS...IT'S FROM ELCO



3301 — Socket with flat saddle



3304 — Socket for use with or without mounting ring

Combination
TRANSISTOR SOCKET

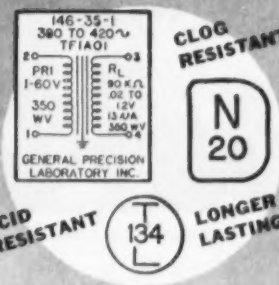
Elco's new Series 3000 multi-purpose transistor socket may be used for 3-pin transistors with in-line pins or with pins on a .200" diameter pin-circle, accommodating triangular pin configuration; thus eliminating the need for stocking different types of sockets for variations in pin layouts. You can now, for the first time, punch a round hole in your chassis!

The insulator body is made of low-loss mica-filled phenolic, type MFE, in accordance with the latest issue of Specification MIL-P-14. Contacts are beryllium copper, gold-plated over silver plate to pass the 48-hour salt-spray test per Specification QQ-M-151a, and afford excellent contact resistance values. Sockets are available for mounting with flat saddle or mounting ring in standard wiring applications.

Complete data and specifications are offered in our Bulletin 105, together with prices and other pertinent information you request upon your company letterhead.

ELCO CORPORATION, M BELOW ERIE, PHILADELPHIA 24, PA., CU 9-5500

NEW! ENGRAVED
Rubber Dies and Stamps!



- Now you can get clean, clear, sharp, even impressions everytime with Krengel Deep-Kut Engraved Rubber Dies and Stamps. Lasting impressions remain on metals . . . printed materials . . . textiles . . . glass . . . on any surface.
- We make Deep-Kut Engraved Rubber Dies and Stamps for every marking unit . . . any type style or logotypes. Anything you need in any quantity you desire.
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Little Mag says . . .

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Magnatran heavy duty components including unitized rectifiers, are the "standard" power supplies in the vital transmitters completing the system.

Whenever you require reliability and dependability you too can use.

Magnatran transformers.

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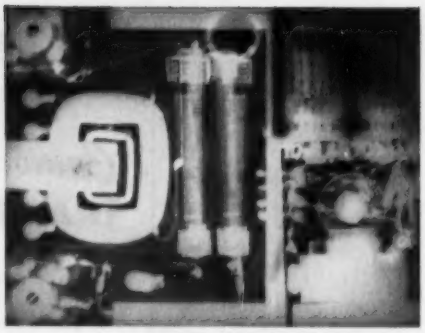
P.O. Box 211 KEARNY, NEW JERSEY, U.S.A.

See page 39
'56 Electronic Buyers Guide

how to get more volts per pound at high altitudes



PROBLEM: Design a *regulated* high-voltage dc power supply for operation at high altitudes. Specifications:
• Input voltage—400 cps ± 10% • Output—dual: 4 KV at 2.5 ma; 8 KV at .3 ma • Regulation—no load to full load within 1% • 105 cubic inches maximum • Light as possible.

SOLUTION: We designed a vacuum tube regulator circuit, with the regulator tubes kept at low voltage. Result: The tubes could be mounted externally—for easy replacement.

For compactness and to protect high-voltage components against the hazards of moisture or rarefied air, we cast the rest of the unit in epoxy resin.

The assembly weighs only 6⅝ lbs., occupies 96 cu. in., plus terminals.

This sort of engineering can be at your service too. When *you* need electronic assemblies—by hundreds or thousands—straightforward or special design—make use of our production and design experience and facilities.

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3. **WELDED RIBBONS**—Dissimilar metal ribbons of the same width can be continuously welded together, within close overlap tolerances.

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director of the company in 1950 and in 1952 became vice-president of research.

Burroughs also announced the appointment of U. Clarke S. Dilks as manager of the research division of the Research Center.

In his new position Dilks will have responsibility for the applied research and technique development. He will also direct the basic work in support of long-range corporation product objectives particularly those utilizing transistors, magnetic material.

Prior to his appointment, Dilks, who joined Burroughs in 1948 as manager of the electromechanisms department, was an associate director of the research activity. He had also been a technical consultant and a member of the research activity's technical planning staff.

Air Associates Ups Three Engineers

Clyde C. Councilman

CLYDE L. COUNCILMAN has been appointed chief engineer of Air Associates.

He will direct the operation and administration of the engineering departments which are responsible for all products developed and manufactured by the company. Prior to his advancement, he served for seven years as project engineer and as a section head within the company.

Marcus C. Eliason was named general sales manager of the company.

In 1947, Eliason was affiliated with Air Associates as a project

Polyethylene for RUGGED SERVICE

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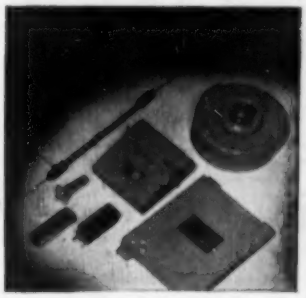

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C 22	5.5	184	.44
C 3	5.4	197	.64
C 33	4.8	220	.64
C 4	4.6	229	1.03
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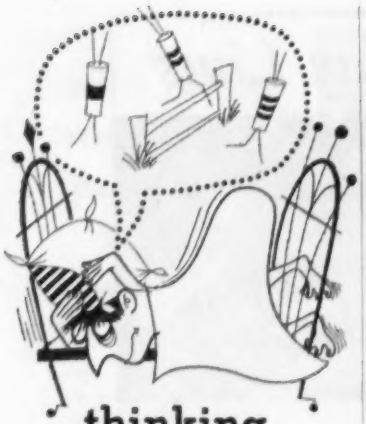

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engineer leaving in 1949 to join the research and development labs of the Hughes Aircraft Co., as a systems engineer. In 1954, he rejoined Air Associates in the position of sales manager in the electronic equipment division.

Charles Knight has been appointed as general manager of Air Associates' facsimile equipment division in Orange, N. J.

Knight will now be responsible for all aspects of the company's facsimile program, which includes the planning of engineering programs, sales and sales promotion, production requirements and service.

Knight, who has 17 years' experience in electronics and allied fields, has been with Air Associates for nine years, during which time he has served as chief design engineer and administrative engineer.

Electronic Research Names Top Engineers

ELECTRONIC RESEARCH ASSOCIATES of Nutley, N. J., manufacturers of transistor and tubeless equipment, appointed Sidney Moskowitz, formerly chief engineer, to the position of director of engineering.

He was engineer at Industrial Scientific Corp. specializing in industrial electronics. He has been an instructor at the City College of New York and in 1950 served as adjunct professor at New York University. From 1943 to 1954 he was with Federal Telecommunications Laboratories where he was engaged in development of

Sidney Moskowitz

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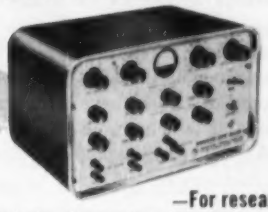

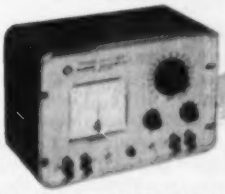

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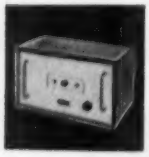

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pulse communication equipment and guided missile guidance systems and served as department head. He joined Electronic Research Associates in 1954 to head the engineering staff.

Martin Perry has joined the company as chief engineer.

He was formerly the chief radio engineer of C.B.S.-Columbia where he was engaged in the development of a line of radio receivers including several transistor radios. Prior to C.B.S.-Columbia, Perry was a senior design engineer at Emerson Radio.

Altec Lansing Builds New Plant

CONSTRUCTION has started in Anaheim, Calif. on Altec Lansing Corporation's third Southern California factory. The new plant and corporate headquarters represent an investment in excess of $1,200,000 and will provide Altec with a total production and engineering facility of 200,000 sq ft.

The new plant will have acoustic laboratories which include three comparative listening rooms and a 6,500 cubic foot anechoic chamber.

Portions of the Beverly Hills and Los Angeles operations will be transferred to Anaheim in order to provide increased facilities for all phases of the firm's manufacturing activities including the Peerless transformer division. Partial occupancy of the 14 acre site near Disneyland is scheduled for November with the full occupancy taking place in January of 1957.

Applied Electronics Completes Plant

NEW plant of Applied Electronics Co., manufacturers of marine and industrial communications equipment, has been completed in San Francisco, Calif.

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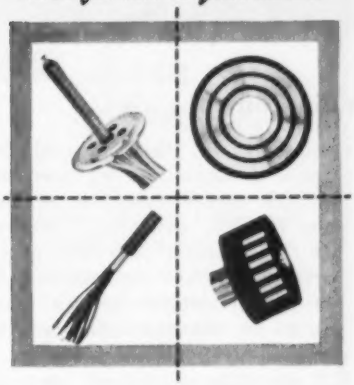

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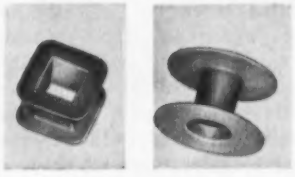

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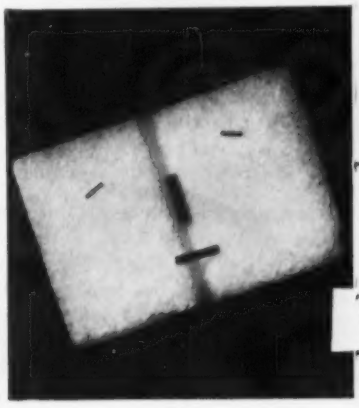

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New Books

Random Processes in Automatic Control

BY J. HALCOMBE LANING, JR. AND RICHARD H. BATTIN

McGraw-Hill Book Co., Inc., New York, 1956, 434 *p*, $10.00.

THE rapidly developing theory of random processes and its application to control systems is the subject of a book by J. Halcombe Laning, Jr. and Richard H. Battin who have themselves contributed to the development of this subject. Much of the material presented has not been available previously except in technical periodicals making this book a timely publication which should be of considerable use to control system engineers.

▶**Topics Covered**—After two introductory chapters which present the elements of probability theory and random processes, the authors consider in turn Gaussian random processes, stationary and nonstationary processes, Weiner's smoothing and prediction problem and finally the optimum design of control systems when the assumptions of Weiner's theory are removed or replaced. This material is supplemented by a fairly large appendix which considers, among other things, the effect of a limiter on Gaussian noise, the description of analogue computers, orthogonal functions and various other mathematical considerations which were omitted in the body of the text. Problems are given at the end of each chapter and a bibliography consisting of 49 items appears at the end of the text.

The presentation of the material is suitable for a graduate level course on this subject. Mathematical rigor and heuristic arguments are both used and the authors are careful to point out when an argument is not completely rigorous.

▶**Illustrative Examples**—Concepts which are glossed over in many texts are well explained. The many illustrative examples will be welcomed by the engineer who is not familiar with the concise mathematical technique with which this subject is usually presented. Moreover, many of the intermediate steps in a derivation are given so that the reader need not supply these himself. Readability of the text is enhanced by the summarizations of the arguments used and by the enumerations of the reasons for the study of each new topic.

It should be pointed out however that the reader needs a knowledge of mathematics beyond that which is generally given in an undergraduate engineering curriculum. For instance, on page 76 a knowledge of matrix algebra is assumed and an explanation of matrix methods at this point might have been useful. Other instances of similar omissions were noted such as the assumption of a minimum in the discussion of orthogonal functions on page 382 rather than its proof.

These criticisms are, however, minor. This book is a well written account of recent developments in statistical methods as applied to control systems and it should be successful both as a textbook for graduate courses on this subject and as a reference book for practicing engineers.—ARMEN H. ZEMANIAN, *College of Engineering, New York University, New York.*

Principles of Color Television

BY KNOX MCILWAIN AND C. E. DEAN

John Wiley and Sons, Inc., New York, 1956, 596 p, $13.00.

SHORTLY after the NTSC completed its work on the compatible color standards, the Hazeltine Corporation prepared for its licensees a series of reports on the NTSC color system and its implementation in circuits and equipment.

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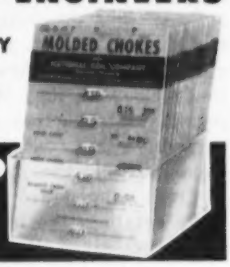

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stituted an authoritative and well-written review of the subject, an achievement marred only by the restricted distribution inherent in a licensee service. This restriction has now been removed by the publication in book form of these reports, brought up to date in text and references.

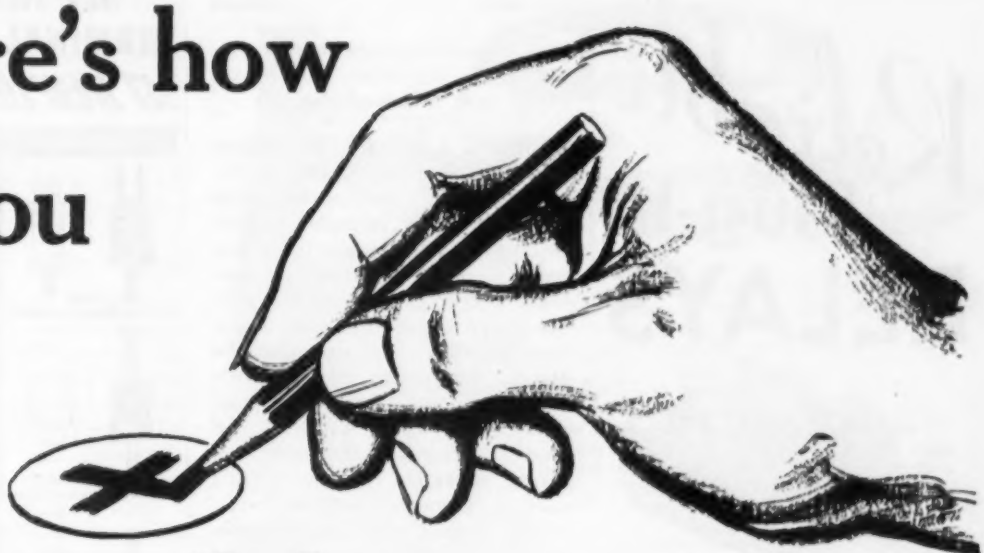
This is an excellent book, one which shows every mark of great care in its writing and editing, accurate and comprehensive, yet easy to read. It probably could not have been written by one man at this stage in the game; actually 12 men contributed to it, eight of whom served on the NTSC panels. Yet, it reads with the coherence of a one-man job, a tribute to the firm hand of Messrs. McIlwain and Dean who edited it.

▶ **Colorimetry**—Any book on color television perforce deals with concepts new to the majority of its readers, so great effort has been taken to explain, or at least to make plausible, the many colorimetric mysteries which underlie the compatible system and its relationship to the prior art of color reproduction. This reviewer, despite copious previous exposure to the subject matter, found himself remarking more than once "well that's clear, at long last" in reading the introductory chapters.

Despite this concern with basic fundamentals, the authors do not hesitate to go into strict, brass-tacks detail in the latter chapters. Moreover, since the authors are not committed to a strict regimen in the choice of circuits and components, the coverage is broad. For example, a 45-page chapter is devoted to the special problems for decoding the NTSC signal for single-gun picture tubes, following an equally comprehensive chapter on the three-gun approach.

▶ **References**—Thirty-two pages are devoted to the author and subject indexes, and the reference lists can only be described as completely adequate, as witness 72 references in the chapter on gamma correction and nonlinearity, 111 items on the generation of the transmitted signal. The references for the most part contain detailed page-number delineations, showing

here's how you "govern" the government



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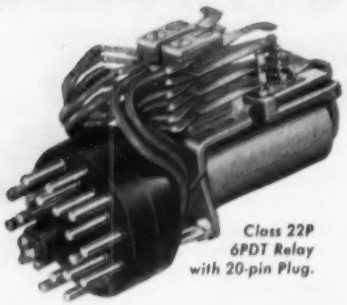

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that the authors have actually consulted the literature, not merely culled over tables of contents.

▶**Subjects Covered**—The chapter headings are: light and photometry; color perception; color space and color triangles; colorimetry; color in a television system; required information content; characteristics of the eye; the choice of color components and their interleaving in the composite signal; production of composite color signal; synchronization; nonlinear amplitude relations and gamma correction; the color television standards of the NTSC; equipment for producing the transmitted signal; color television receivers; decoders for three-gun displays; decoders for one-gun picture tubes; test and measuring methods; glossary of color television terms and three appendices on the luminance contributions of primaries, the color-signal formulas and the complete text of the FCC order setting up the compatible system.

This reviewer knows of six books, including this one, now in print on color television technology, and he also knows that the "Guild of Reviewers" frowns on too explicit ranking of competing books. But when one volume stands preeminent (for whatever special reason, including all-out support of the project by an organization which can afford to put 12 authors on the job) it deserves to be identified as such. "Principles of Color Television" leads the league.—DONALD G. FINK, Philco Corporation, Philadelphia, Pa.

Transistors in Radio and Television

By MILTON S. KIVER
McGraw-Hill Book Co., New York, 1956, 324 p, $6.50.

TRANSISTORS are no longer curiosities in the world of electronics. By now it is obvious that they can do just about anything the electron tube can do, at least in the audio and lower radio-frequency ranges. It therefore behooves everyone connected with the technical end of the industry to understand what transistors are and how to use them. This is as important for the tech-

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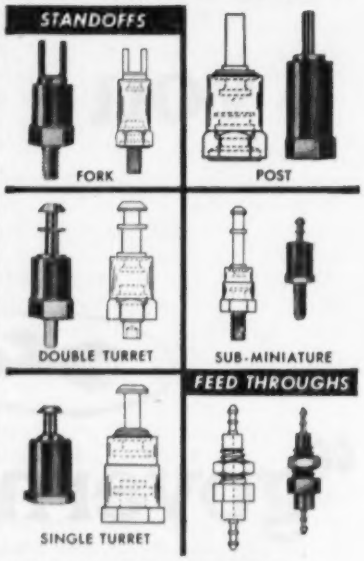

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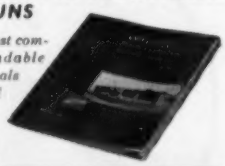

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nician as for the circuit-design specialist.

This book is designed to introduce the radio and television technician to the transistor art. It is recommended for use in technical institutes, radio and television schools, colleges, high schools, training programs and home study.

▶**Theory**—The book begins with an introduction to modern electron theory. The second chapter discusses point-contact and junction transistors. Building upon his introduction to electron theory the author makes the flow of electrons and holes appear quite reasonable to the student and gives him a working understanding of transistor action. A comparison of point-contact and junction transistors follows.

▶**Circuits**—The author then discusses the more common transistor amplifier circuits and their use in radio and television receivers. This constitutes nearly two-thirds of the book and provides sufficient entertainment type circuits with component values given.

The book concludes with 13 simple laboratory experiments designed to give the student a feel for working with transistors. A comprehensive bibliography covers the eight years that the transistor has been with us and several pages of data, reprinted from ELECTRONICS, giving useful characteristics of commercially available units.—J.M.C.

Thumbnail Reviews

Solid State Physics. Vol. II. Frederick Seitz and David Turnbull. Academic Press, New York, 1956, 468 p, $10.00. Second semiannual volume in series planned along the lines of "Advances in Electronics and Electron Physics". Covers magnetic resonance, electron paramagnetism and nuclear magnetic resonance, neutron diffraction, specific heats and lattice vibrations, and displacement of atoms during irradiation.

Radiation Dosimetry. Gerald J. Hine and G. L. Brownell. Academic Press, New York, 1956, 932 p, $22.00. Problems in determining energy absorbed in material exposed to radiation. Covers theory and measuring units also

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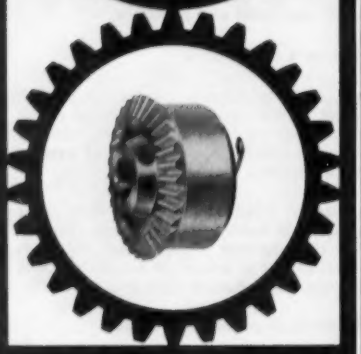

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medical and biological effects. Of interest to electronic engineers are sections on ionization chambers, geiger counters, scintillation detectors and various dosimeters and area-survey equipment. Also means of producing radiation such as high-energy beams and isotopes.

The Theory of Sound (Two Volumes). Lord Rayleigh. Dover Publications, New York, 1956, 984 p, $3.90 (paper). Reprint of Lord Rayleigh's classical work first published in 1877. Historical introduction includes biographical sketch of author and historical development of acoustics to the time of Rayleigh.

Radio Receiver Laboratory Manual. Alex W. Levey. John F. Rider Publisher, New York, 1956, 112 p, $2.00 (paper). Construction and testing of radio receivers. Thirty three practical laboratory experiments for course on technical school level.

Debunching in UHF Velocity-Modulated High Density Electron Beams. Myron Weinstein. Office of Technical Services, Washington, D. C., 1956, 100 p, $3.00 (paper). Highly technical report on Air Force sponsored work carried on at the University of Illinois Engineering Experiment Station.

Picture Book of TV Troubles, Vol. 5, Horizontal Output and H-V Circuits. John F. Rider Publisher, New York, 1956, 108 p, $1.80 (paper). Trouble shooting television receivers. Presents oscilloscope waveforms and photographs of tv screen.

R-F Transmission Lines. Alexander Schure. John F. Rider Publisher, New York, 1956, 72 p, $1.25 (paper). Fundamental concepts of transmission lines, operation and characteristics with essential formulas and applications including use of stub lines for matching.

Computer Applications. Armour Research Foundation, Chicago, Ill., 1956, 108 p, $3.00 (paper). Proceedings of symposium held during October 1955. Includes fourteen papers on use of digital computers in industry, business and engineering.

Peaceful Uses of Atomic Energy, Vol. 15, Applications of Radioactive Isotopes And Fission Products in Research and Industry. Columbia University Press, New York, 1956, 327 p, $7.50. Covers several industrial process control applications of interest to electronics engineer including use of isotopes in chemical analyses, determining rate of flow and liquid level.

Frequency Response. Rufus Oldenburger. The Macmillan Company, New York, 1956, 372 p, $7.50. Based primarily on papers presented to ASME

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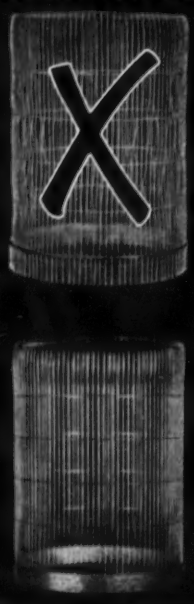

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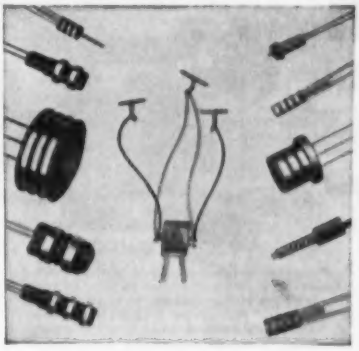

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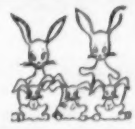

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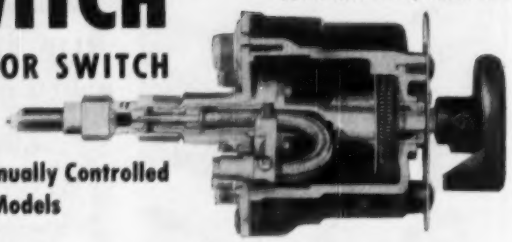

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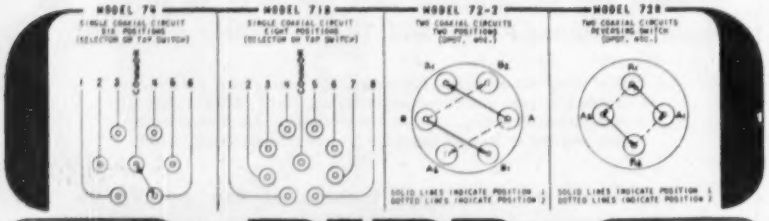

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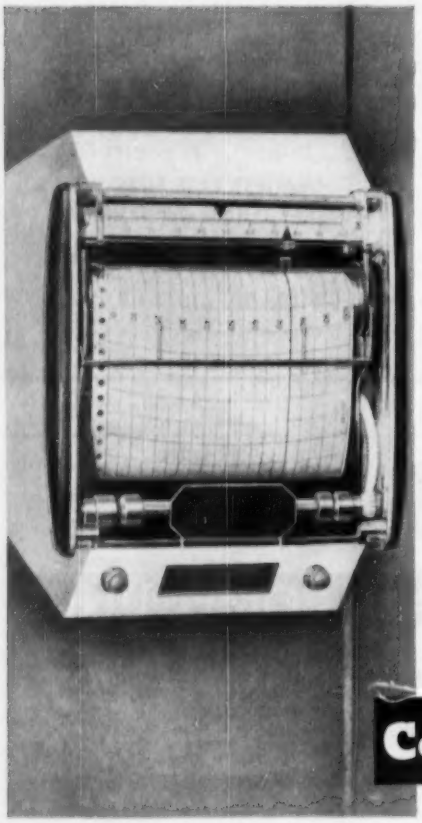

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Frequency Response Symposium held in New York during December 1953. Includes other recent papers. Twenty eight papers in all cover fundamentals, frequency-response aids, servo applications, process control, transient response, optimum controls, nonlinear techniques, sampling controls and statistical methods.

Electromagnetically Enriched Isotopes and Mass Spectrometry. M. L. Smith. Academic Press, New York, 1956, 272 p, $8.00. Collection of thirty papers presented to Conference on Electromagnetically Enriched Isotopes held at Harnwell, England in September 1955. Includes information on design of mass spectrometers as well as analytical techniques.

Radio Annual Television Year Book 1956. Jack Alicoate. Radio Daily Corp., New York, 1956, 1,376 p. This is the nineteenth annual edition of this broadcasting industry reference book. It is strictly nontechnical. It provides statistics, market information, lists or general information on the broadcasting business as a whole. Subject divisions include, advertising agencies; a-m, f-m, tv stations in the U. S., Canada, Mexico, South America; tv and radio performers and program producers; Canadian Broadcasting, manufacturers of broadcast equipment, FCC; group station operations; networks; industry organizations; station representatives; transcription and recording companies.

Glossary of Terms Relating to Automatic Digital Computers. British Standards 2641: 1955. Published by British Standards Institution, 2 Park Street, London, W.1, 1956, 16 p, 3 shillings. Definitions of 95 terms peculiar to digital computers and related terms on number scales and number representations.

Technical Papers, Vol. II. Twelfth Annual National Technical Conference, Cleveland, Ohio. Published by The Society of Plastics Engineers, Inc., 1956, 618 p, $7.50. Complete versions of 56 papers on injection molding, epoxy resins, properties of plastics, molding and extrusion, thermoplastic sheets, reinforced plastics, and foam plastics, many directly applicable to electronic equipment design.

Elementary Nuclear Theory. Bethe & Morrison. John Wiley & Sons, New York, 1956, 274 p, $6.25. Selection of topics in the field of nuclear energy. Including description of nuclei, quantitative theory of nuclear forces and beta decay in complex nuclei. Topics are treated in elementary fashion.

Blocking Oscillators. Alexander Schure. John F. Rider Publisher, New York, 1956, 72 p, $1.25. Comprehensive review of circuit configurations on the technical level.

Backtalk

Chopper Improved

DEAR SIRS:

THE high-level electronic chopper for d-c amplifiers (ELECTRONICS, p 192, Nov. 1955) uses series selenium rectifiers to reduce the negative plate voltage swing on the cathode follower triodes (ELECTRONICS, p 444, April 1956).

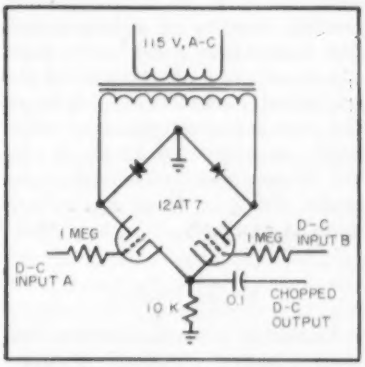

FIG. 1—Bridge electronic chopper for d-c amplifiers

The same components can be rearranged in a bridge circuit (Fig. 1) to switch the cathode followers on alternate half cycles but with even less back voltage on the triodes. The circuit grounds the alternate triode plate so it cannot go negative.

Also, only half the transformer secondary voltage is needed, as usual in bridge rectifiers.

R. R. MCPHERSON
Graduate Research Assistant
Electronic Defense Group
University of Michigan
Ann Arbor, Michigan

Channel Splitting

DEAR SIRS:

ON page 22 of the September, 1956, edition of ELECTRONICS it was reported under "FCC Actions" that action may be forthcoming on the two-year-old channel-splitting docket. It further stated "Police radio men have not favored splitting."

This Association represents police communications and filed a brief with the Federal Communications Commission on this docket supporting and favoring the split channels. Our Association has long recognized the inadequacies of the present allocation and the need for additional channel space. We strongly feel that the split-channel docket will provide much of the needed relief.

The State Police Sub-Committee of this Association, representing the State Police licensees operating in the radio spectrum from 42.02 mc to 45.06 mc, filed a minority report with the Commission opposing split channels in the State Police assignment. Their comments, however, offered no objection to channel splitting of frequencies other than those assigned exclusively to State Police operations.

As your article conveys the opinion that police radio men in general do not favor channel splitting it would be appreciated if you might clarify this situation in a future issue.

ROBERT A. MASON
Associated Police
Communications Officers
San Jose, California

Double Scale

DEAR SIRS:

IN the September 1956 issue of ELECTRONICS, on page 141, you had a short paragraph in "Cross Talk" concerning the fact that research people use the Centigrade scale while production people use the Fahrenheit scale for temperature.

We too have this problem. Do you have any good suggestions?

CLAYTON DOREMIRE
Manager
Electrical Industry Sales
Dow Corning Corporation
Midland, Michigan

Editor's Note: Perhaps readers in both fields can help.

Noise and Systems

DEAR SIRS:

I HAVE enjoyed the recent series by W. R. Bennett on the various aspects of noise, but Part V (p 148, July 1956, ELECTRONICS), "Reducing Noise in Communications Systems," seems misleading.

The article is partisan to the extent of omitting the limitations

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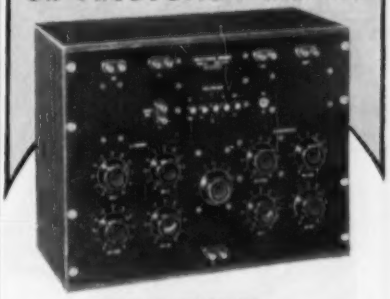

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and deficiencies of pcm while extolling its virtues. It also avoids any unfavorable comparison of pcm with other modulation systems.

It is interesting to compare a pcm/a-m system with an f-m system having equal bandwidth, equal peak r-f power and equal r-f signal to noise ratio. Starting with the pcm/a-m system: assume a seven-digit binary code is used. The seven digit code yields a pcm s/ń ratio of about 47 db. To assure perfect decoding of a pcm signal, the instantaneous s/n ratio must always exceed 6 db. Because of the statistical relationship between the rms and peak values of white noise, an additional 12 db of signal is provided to override noise peaks. Thus, an 18-db rms r-f s/n ratio is assumed.

Design Problem

To design a comparable f-m system, it is first necessary to determine the r-f bandwidth of the pcm system. The maximum information frequency (f_m) is sampled 2.5 times per cycle, and each sample requires 7 digits (ignoring any necessity for synchronization). To facilitate the decoding operation, harmonics of the digit repetition frequency also should be passed through the system. Assume that the third harmonic is required. Before the modulation is applied to the transmitter, it contains frequency components up to 2.5 x 7 x 3 x f_m or 52.5 f_m. Using amplitude modulation, the r-f spectrum is twice this or 105 f_m.

An equivalent bandwidth f-m system will have an improvement factor of 39 db (from a modulation index of 52). Assuming an 18-db r-f s/n ratio for both the pcm and f-m systems, the final s/n ratio averages 57 db for f-m compared with 47 db for pcm.

The required r-f bandwidth for pcm, as in other pulse systems, is not an absolute figure; therefore, some argument could arise about the correctness of the preceding numbers and initial assumptions, but the conclusion will remain: f-m does a better job than pcm/a-m under the stated conditions.

In defense of pcm, increasing

the number of binary digits from 7 to 8 increases the pcm bandwidth by a factor of only 8/7 but improves the s/n ratio by 6 db. A similar increase in f-m bandwidth increases the f-m s/n ratio by only 1.16 db. Adding a ninth digit increases the pcm bandwidth another 6 db, but the corresponding f-m s/n ratio improves by only 1.02 db.

This conforms with some statements by the author: "Frequency modulation is not the most efficient way of exchanging bandwidth for signal-to-noise ratio. The ultimate bargain is reached by pulse code modulation. Instead of direct proportionality of rms signal-to-noise ratio with bandwidth, pcm gives an exponentially increasing improvement with bandwidth."

Although rate of trading bandwidth for s/n ratio is exponential for pcm and linear for f-m, the pcm signal will be inferior to f-m if fewer than perhaps 8 or 9 digits are used. It is true that adding more digits to the pcm will improve the pcm s/n ratio much more rapidly than an equivalent increase in f-m bandwidth. Conversely, if fewer digits are used, pcm becomes rapidly worse than f-m.

Relay Problems

The r-f bandwidth at which pcm becomes superior to f-m is of the order of a hundred times the maximum frequency component (f_m) of the original information. Thus, at extremely wide bandwidths pcm can have advantages over f-m and other modulation systems. If a system designer could ignore the complexity, size and cost of pcm equipment and if several hundred kilocycles of r-f spectrum were available for a communications quality speech channel (f_m=3 kc), then pcm might be the best answer.

If a signal is to be transferred through many relay stations, pcm has the much publicized advantage that the signal may be regenerated to its original coded form at each relay station, and so only the original quantitizingnoise degrades the information at the final receiving station. However, even in some systems where a signal is relayed several times, other types of modulation will prove superior to pcm.

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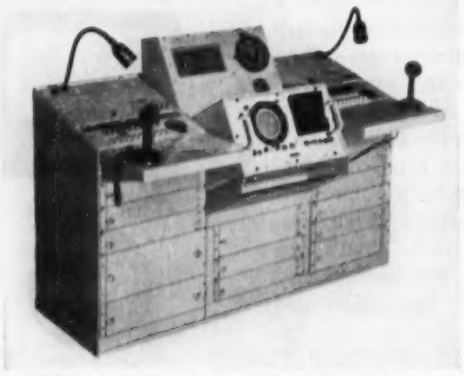

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careful analysis of system requirements, equipment cost, carrier power attainable, bandwidth available, antenna suitability, atmospheric vagaries and many other factors; then, with the aid of the gods, he can achieve a reliable system having the desired s/n characteristics.

In summary: contrary to what might be inferred from the article, pcm simply isn't the panacea for communication system noise problems.

M. R. BECKMAN
U. S. Naval Air Missiles Test Center Point Mugu, California

DEAR MR. BECKMAN:

RESPONSE to the articles on noise has been highly gratifying and I would like to express my thanks to you and others for taking the trouble to write letters about the subject. Differences of opinion are healthy symptoms and discussions of them should aid in better understanding of the problems.

I did not intend to claim unconditional superiority of pcm over all other transmission systems in combatting noise. Individual transmission problems require individual scrutiny and certainly there are cases where f-m, for example, is a more sensible choice. It is difficult to make general statements in a brief article without including a certain amount of semantic noise which could lead to wrong conclusions.

The main advantage of pcm over all other systems is that it can exploit bandwidth to prevent accumulation of noise effects from successive repeaters in a long system. There are ranges of bandwidth and numbers of repeaters for which f-m does well enough and, in fact, may be better than pcm for specific conditions and requirements. But since noise does disturb the frequency as well as the amplitude of an r-f wave, some noise must be accepted in the signal output circuit of the most ideal f-m detector. Even small contributions can sum up to objectionable totals when the number of sources is large. Increasing the number of links in an f-m system reduces the allowable noise contri-

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bution from each one and calls for increments in power or bandwidth in the individual links. At some point depending on the economics of the particular situation a changeover to pcm becomes profitable. From there on more links can be added without making the requirements more stringent.

I do not have any serious objections to your analyses of specific cases. You have been somewhat extravagant in assigning bandwidth to pcm but this is a matter of engineering judgment as to choice between operating with detached wideband pulses versus overlapping narrow band ones.

One comment I would like to make is that the kind of bandwidth needed for pcm is not at all the same as the bandwidth needed for f-m. The pcm band can be cluttered with noise, interference, and waveform distortion to a considerably greater extent than the f-m and still be satisfactory for a long system. The choice then may be between a narrow band requiring high precision and a wider band with generous tolerances.

It is possible to cite examples in which pcm, in spite of its wideband, is able to get a signal through a medium for which a narrow band method would fail. Consider a pair of wires in a telephone cable. The attenuation is proportional to length and to the square root of the frequency. How much bandwidth is there? Practically the bandwidth is unlimited if you are willing to use short segments separated by repeaters. With an analog transmission system the maximum number of repeaters is limited by the increasingly severe requirements which must be placed on them and hence the bandwidth is also limited. With pcm, the number of repeaters can be increased to the point where the bandwidth of each section is sufficient, while with analog this might not be possible.

A monograph by C. B. Feldman and myself deals with a number of these problems in more detail. There is no claim for an all-inclusive set of answers.

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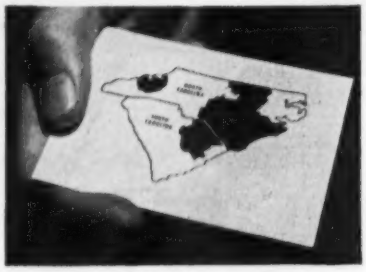

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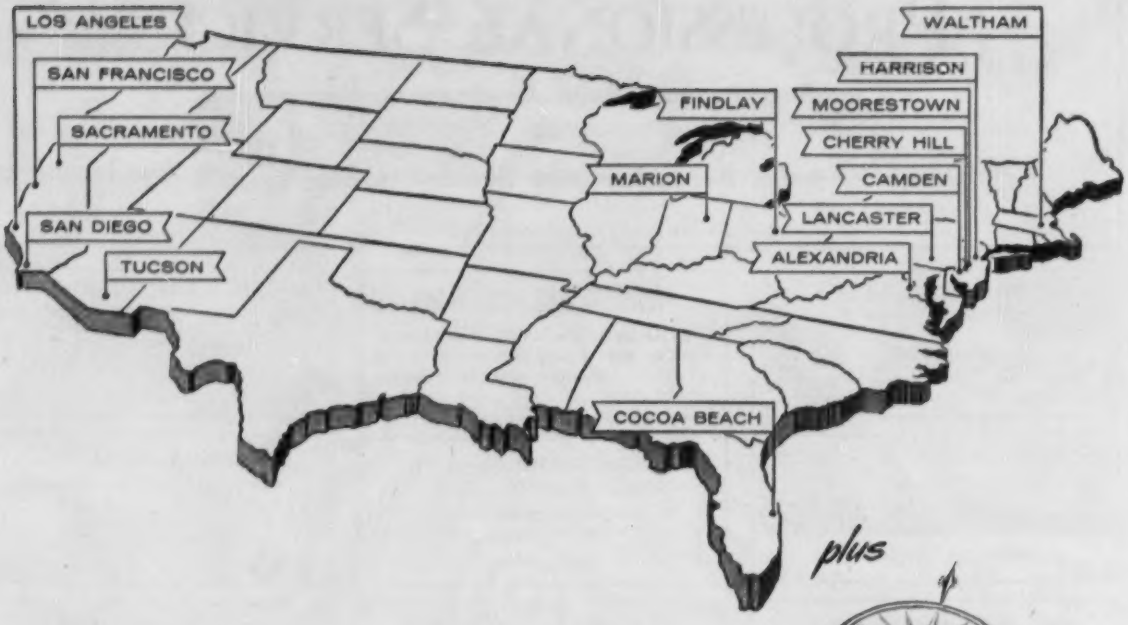

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Locations: C—Camden, N.J. **F**—Cocoa Beach, Fla. **H**—Harrison, N.J. **I**—Clark, N.J. (periodic foreign assignments). **L**—Lancaster, Pa. **M**—Moorestown, N.J. **N**—New York, N.Y. **S**—RCA Service Co. (Cherry Hill, N.J.; Alexandria, Va.; Tucson, Ariz.; San Diego, Sacramento, San Francisco, Calif., Foreign Assignments). **V**—Somerville, N.J. **W**—Waltham, Mass. **X**—West Los Angeles, Calif. **Y**—Marion, Ind.

Please send resume of education and experience, with location preferred, to:

Mr. John R. Weld, Employment Manager
Dept. A-15L, Radio Corporation of America
30 Rockefeller Plaza, New York 20, N.Y.

RADIO CORPORATION of AMERICA

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EMPLOYMENT OPPORTUNITIES

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

Positions Vacant
Positions Wanted
Part Time Work

Civil Service Opportunities
Selling Opportunities Wanted
Selling Opportunities Offered

Employment Agencies
Employment Services
Labor Bureaus

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The advertising rate is $25.25 (effective Jan. 1957) per inch for all advertising appearing on other than a contract basis. Frequency rates quoted on request.
An advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.
Subject to Agency Commission.

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Position Wanted ads are ½ of above rate.
Discount of 10% if full payment is made in advance for 4 consecutive insertions.
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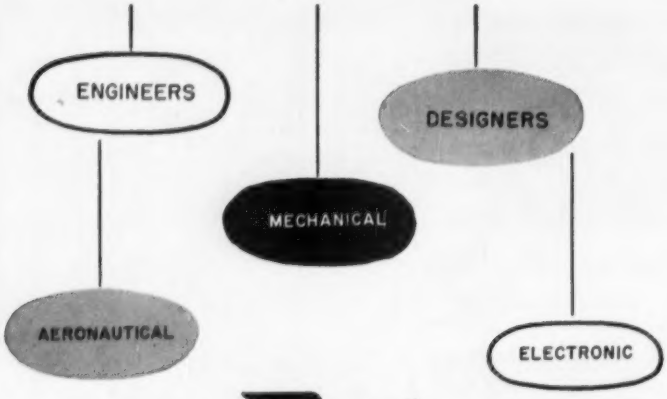
Send NEW ADS or inquiries to Classified Advertising Division of ELECTRONICS, P. O. Box 12, N. Y. 36, N. Y., for December issue closing November 1st.



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In South Bend, hundreds of professional people have found a community adequately satisfying for a highly educated way of life. Notre Dame is an excellent center for technical, graduate study, as well as affording cultural opportunities.

Immediate openings available in research, design, test and development:

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AIRCRAFT LANDING GEAR →
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Heat Transfer
Stress Analysis
Structure
Systems and Component Design or Testing

AUTOMOTIVE COMPONENTS →
Conventional Brakes
Hydraulic Systems
Mechanical Design and Test
Power Brake Research
Power Steering

If you are interested in any of these engineering projects, send a summary of education and experience to:

Technical Employment,
Department C-4
BENDIX PRODUCTS DIVISION OF
BENDIX AVIATION CORPORATION
401 Bendix Drive
South Bend, Indiana

Research Opportunities at Battelle Institute

**ELECTRICAL ENGINEERS,
MECHANICAL ENGINEERS,
INDUSTRIAL ENGINEERS,
PHYSICISTS, and MATHEMATICIANS**

interested in RELIABILITY ENGINEERING are urged to investigate the employment possibilities at BATTELLE.

Professional assignments offer outstanding growth possibilities in the field of electronics and engineering in general.

The Technical Educational Program furnishes the opportunity to secure an advanced degree at no expense to the technologist.

The Benefit Program provides four weeks' vacation after only five years' employment.

FOR DESCRIPTIVE MATERIAL AND TECHNICAL APPLICATION FORM, WRITE TO:

Mr. Russell S. Drum
Reliability Engineering Research
BATTELLE INSTITUTE
Columbus, Ohio

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Permanent positions are available at all levels of experience in the Communication and Radio Frequency Section of a large Midwestern research and development organization. We need qualified personnel to work in.

Electronic Countermeasures
Microwaves
Radio and Radar
Antennas and Propagation
Communications Systems

Here is an excellent opportunity to join the staff of a progressive, growing organization; work on challenging and diversified research programs; receive liberal educational benefits; and enjoy optimum professional associations along with new air-conditioned facilities.

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ARMOUR RESEARCH FOUNDATION
of Illinois Institute of Technology
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DESIGN ENGINEERS

Come to New England... And Continue to Work on

ICBM—
TALOS—
MISSILEMASTER

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The Electronics Division of American Machine & Foundry Company, Boston, now engaged in missile systems programs, affords exceptional opportunities for Design Engineers who desire the exhilarating New England way of life—at salaries enabling you to enjoy four season recreation, outstanding educational environment, attractive homes, friendly communities.

LONG RANGE ASSIGNMENTS FOR CIRCUIT DESIGN ENGINEERS

Experienced in Wave Forming and Timing, Microwave, Relay Switching, Digital Data Processing, Transistors and Servos

AMF offers extensive benefits including temporary housing allowance, liberal relocation assistance and tuition reimbursement plan for advanced study.

Please send complete resume to:
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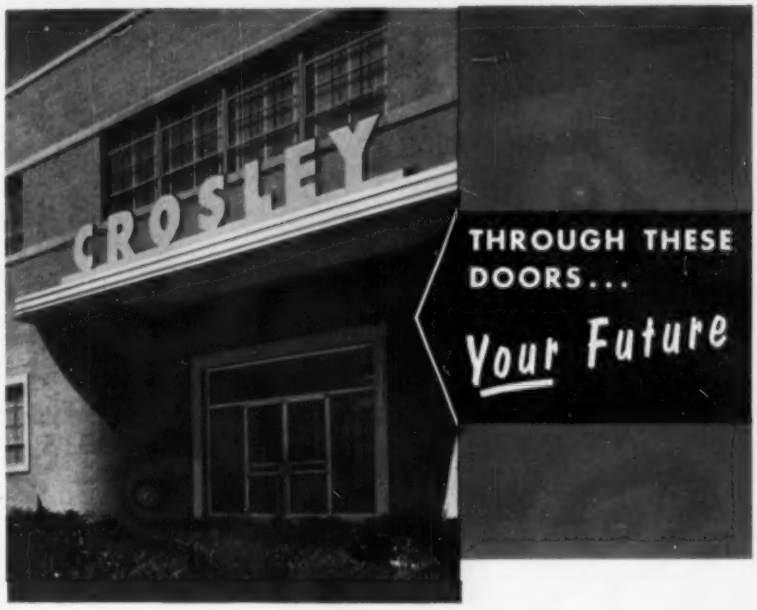
Director of Engineering
ELECTRONICS DIVISION

American Machine & Foundry Company
1085 Commonwealth Ave.
Boston, Mass.



We have present openings for experienced Electronic Engineers in the design and development of ground radar systems, airborne transmitters and receivers and in the electrical systems of guided missile fuzes.

We also have a need for Mechanical, Aeronautical and Structural Engineers of the same experience levels in the design of servomechanisms, the design of large, light-weight structures of the airframe variety and the design and layout of electronic and electromechanical chassis and packages.

In the computer field, we have a need for Physicists and Mathematicians for the programming and solution of engineering problems utilizing analog computers and IBM equipment. Experience in the development of new applications and techniques for digital and analog computers combinations is also desirable. Attractive openings also available for Packaging Engineers, Technical Writers and Illustrators.

CROSLEY'S continued and extraordinary success in the sphere of government electronics, has placed the name of CROSLEY as one of the forerunners in this ever-expanding field. Our present and anticipated demands call for additional engineering personnel at all levels. CROSLEY offers you a partnership in its continued expansion program—"A Partnership in Opportunity."

CROSLEY has numerous company benefits including a group insurance and retirement plan, subsidized educational program, periodic merit reviews and up to three weeks paid vacation after five years. We would also pay relocation expenses including moving expenses, reporting to work pay, family transportation and a generous subsistence allowance.

Please send your resume to Director of Engineering Dept. T-17

Crosley DIVISION
AVCO MANUFACTURING CORPORATION

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Excellence in Electronics

Which direction are you going?

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Fine Suburban Living
Exceptional educational and cultural facilities
Nearby famous winter sports and summer resort areas, and—

Opportunity to Travel the Road to Success with RAYTHEON in the fields of AIRCRAFT NAVIGATIONAL AND CONTROL SYSTEMS, and GUIDED MISSILES.

As one of the largest, fastest growing and most progressive Electronics Companies in New England RAYTHEON can offer—numerous advancement possibilities, interesting professional challenges, tuition support plan for engineering courses, regular salary review, adequate supporting technical personnel, large company advantages, including Life and Health Insurance, paid vacations, and other employee benefits.

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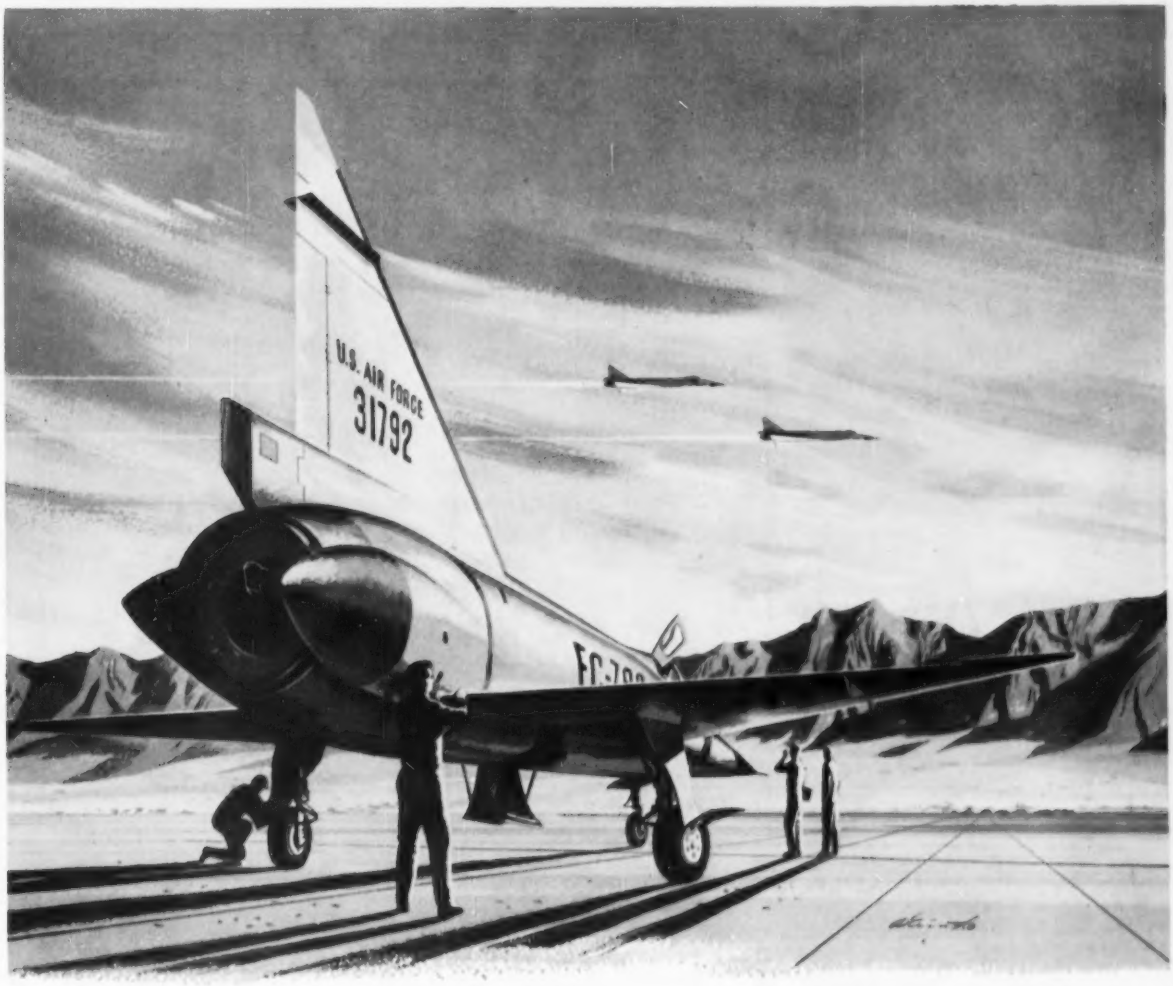
- ELECTRONIC RELIABILITY & TEST EQUIPMENT
- ELECTRONIC PRODUCT DESIGN
- RADAR SYSTEMS
- TUBE APPLICATIONS
- MECHANICAL DESIGN
- ANALOG COMPUTERS
- MICROWAVE COMPONENTS
- AERODYNAMICS
- MECHANICAL PROCESS ENGINEERING
- SPECIFICATIONS ENGINEERING

Call or send resume to
G. P. O'Neil
CRestview 4-7100, Ext. 224

RAYTHEON MISSILE SYSTEMS DIVISION

BEDFORD, MASS.



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The many advanced aircraft and missile programs at Convair San Diego today include: *The F-102A Supersonic Interceptor, The Atlas Intercontinental Ballistic Missile, The Metropolitan 440 Airliner, the new Convair 880 Jet-Liner, and a far-reaching study of Nuclear Aircraft.*

Within these vital, highly-diversified Convair projects in beautiful San Diego, California, engineers find the perfect "climate" for a challenging and rewarding engineering career. You will find Convair salaries, computor and test facilities, engineering policies, educational opportunities and personal working advantages the most desirable in the industry.

What's more, you and your family will almost certainly enjoy a new, exciting, happier way of life here . . . where the weather year 'round is unsurpassed.

For a significant engineering career in the engineering "climate" *you* seek, we invite you to forward a full resume today. Write H. T. Brooks, Engineering Personnel, Dept. 923.

Generous travel and moving allowances to engineers.

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THIS IS THE KIND OF ENGINEERING HELP WE NEED!

Electronic Engineering in telemetering, guidance, radar and particularly circuit designing.

Hydraulic and Servo Engineering in control and autopilots.

Mechanical Engineering in packaging and structures.

Please write us or mail coupon for full information.

W. C. Walker, Engineering Employment Mgr.
Pacific Division, Bendix Aviation Corp.
11600 Sherman Way, North Hollywood, Calif.

I am interested in this engineering field____
I am a graduate engineer with ____ degree.
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Name _____
Address _____
City _____
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Opportunities for project engineers, technical specialists, and design and analytical personnel on high speed aircraft, missiles, and the EARTH SATELLITE.

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Opportunities are available in the following fields:

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MAGNETIC AMPLIFIERS
AUTOMATIC PROCESS CONTROLS

Contact Professional Employment Office

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General Electric's Light Military Electronic Equipment Department is organizing a team of systems evaluation engineers to support a weapons system evaluation program. The team will synthesize weapons systems and consult with design groups.

The following areas of knowledge and experience will be important in the evaluation of a prospective employee's capabilities:

Engineering or Physics degree.
Advanced degree in mathematics, engineering or physics.
Operational experience with weapons systems, aircraft or airborne electronic equipment.
Responsible participation in activities for planning, development, procurement, test and evaluation of weapon systems equipment.
Experience in planned advanced development study and proposal activities of military airframe and electronic producers.

This position is in Utica, N. Y., a cosmopolitan city near the Adirondack resort area.

Reply in confidence to:

Mr. John Sternberg, Dept. 843
LIGHT MILITARY ELECTRONIC EQUIPMENT DEPT.

GENERAL ELECTRIC

French Road, Utica, N. Y.

and how about **your** *tomorrow?*

You're a creative engineer. Today you are practicing your professional specialty in one of the many phases of modern aviation. Because you have faith in your ideas and your ability to make them work, you welcome the challenge of helping transform them into realities that will pay off.

But possibly you find that, all too often, the burden of non-professional tasks consumes a great part of your creative time. Perhaps you seek a place where you can contribute your *technical abilities* to vital aviation problems—a place where you can see your ideas really put to work.

Well, this may be the opportunity you have been waiting for. Because of our continued growth and increased diversification, we must expand our creative engineering staffs at both Akron, Ohio, and Litchfield Park, Arizona. Here at Goodyear Aircraft, you will find unlimited opportunity for professional development in nearly every phase of aviation. Here you will find the stimulation of creative challenge and the satisfaction of realistic accomplishment.

As a Goodyear Aircraft engineer you will come to know that here your *every* idea has a chance. And, to help you prove them, you will have at your disposal the most modern facilities available, including one of the largest computer laboratories in the world. For we have long known that the freedom of creative thought and expression enjoyed by our engineers is a major factor in maintaining the position of Goodyear Aircraft among the leaders in aviation.

You will find salaries and benefits liberal. And as an example of our vital interest in technology, a company-paid tuition program leading to advanced degrees has been established at nearby colleges.

For further information on *your* career opportunities at Goodyear Aircraft, write: Mr. C. G. Jones, Personnel Department, Goodyear Aircraft Corporation, Akron 15, Ohio.

They're doing big things at

GOODYEAR AIRCRAFT

THE TEAM TO TEAM WITH IN AERONAUTICS

"I chose Stromberg-Carlson for opportunity... maybe you should, too"

Stromberg-Carlson offered me and my family so much more than a good salary, plus bonus and a flock of fringe benefits, that I couldn't say anything but "When do I start?"

There's the Company itself—sixteen times bigger today than in 1940—and now a division of the headline-making General Dynamics Corporation. One look at its Electronic Engineering alone convinced me that here is probably the "hottest" electronics industry in America today.

Of course, there's Rochester, and its surroundings. Right in the heart of the Finger Lakes; only four hours from the Adirondacks. Home of the Eastman School of Music and Eastman Theatre; of world-famous parks; of no less than thirteen golf courses; of schools and shopping centers unrivalled in the East; of scientific industries whose engineers turn up as your next-door neighbors.

But above all there's opportunity. As the chap who hired me put it, "This is the spot for men who are either stymied in a little company, or buried in a giant." Opportunity, that's it—no limits to individual initiative and accomplishment—and with all that expansion there sure is going to be a lot of promoting! Brother, here's a place where I can develop! Why not check my conclusions? Start with a brief note to

- Countermeasures
- Data Systems
- Digital Techniques
- Electro-Mechanical Design
- Infrared
- Laboratory and Test Engineering
- Microwave Circuits
- Navigational Systems
- Radar
- Transistor Engineering
- Communication Systems
- Missile Guidance Systems
- Systems Test Equipment
- Writers—Technical
- Components and Specifications

R. W. Holmes, Electronic Engineering

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A DIVISION OF GENERAL DYNAMICS CORPORATION

2 Carlson Road, Rochester 3, N.Y.

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ENGINEERS

What is INERTIAL NAVIGATION?

...what principles recommend this system for flight guidance beyond the earth's orbit?

...can such a system withstand the shock of extreme environmental conditions?

...does it require previous reconnaissance or radiate signals for enemy detection?

You are invited to send for
"AN ANSWER RE: GUIDANCE"
containing 5 technical papers discussing these and other questions relating to Inertial Navigation.

Just mail the coupon for your copy... still better, learn about this significant new field at first hand

To create a missile guidance system that will reach its target unerringly, requiring no terrestrial source of energy, no earthbound direction, involves creative engineering of the highest order. A degree of precision, hitherto unattempted, must also be attained in the essential "hardware."

This is an opportunity which genuinely deserves the over-used adjective "unique"—on a major pioneering program with a company known for its engineering excellence.

Immediate openings for Senior Engineers, Engineers and Associate Engineers experienced in:

SYSTEMS EVALUATION
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DIGITAL COMPUTERS
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GUIDANCE SYSTEMS
RELIABILITY
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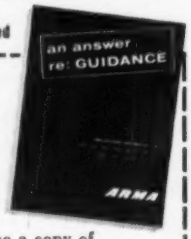
AUTOMATIC CONTROLS
DATA REDUCTION & ANALYSIS
TRANSFORMERS
ENVIRONMENTAL RESEARCH
PRODUCTION TEST EQUIPMENT
GROUND SUPPORT EQUIPMENT

Please forward confidential resume. No reference contact without your permission.

Moving allowances arranged



ARMA
Division American Bosch Arma Corporation
Technical Personnel
Dept. 674
Roosevelt Field
Garden City, L. I., N. Y.

Gentlemen:
Please send me a copy of "AN ANSWER RE: GUIDANCE."

NAME_____

ADDRESS_____

SYMBOL / OF AN ENGINEER'S FUTURE...

RCA offers the opportunity for you to apply your engineering talents to its Missile Test Project at Patrick Air Force Base, Florida—"Launching Site of the Satellite."

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At RCA's Missile Test Project you will enjoy professional advancement combined with famous Florida living. You and your family will appreciate the ideal climate on Florida's Central East Coast which allows year 'round outdoor activities.

Let MTP become a symbol of *your* future!

For complete information about this new and challenging field, write to:

Mr. Wm. T. A. Baxter,
Personnel Manager, Dept. N-10L
RCA Service Company, Inc.
Missile Test Project
P. O. Box 1226
Melbourne, Florida

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SYLVANIA'S rapid growth is almost twice that of the electronics industry as a whole... think what this can mean to *you* in opportunity and rapid advancement. And Sylvania helps underwrite your advanced studies in leading universities in both locations ...because we want you to assume greater responsibility and leadership. Here are some typical problems being solved by Sylvania engineers and physicists in our Buffalo, N. Y. and Waltham, Mass. laboratories.

AT BUFFALO:

1. *How do you design 10 similar microsecond timing circuits whose delay times can be varied over a range of 100 times by analog control voltage maintaining a tracking accuracy of ±0.1% in an environment of −65°C to +125°C at sea level to 100,000 feet?*

2. *If you know which bits of a code group are in error, can you modify the hamming code to use these data to provide maximum information capacity in a noisy channel?*

3. *Can you design a crystal mixer to operate with latest production type crystals and having a noise figure less than 12db above KTB operating in the "S"-band?*

AT WALTHAM:

4. *What are the statistical factors to be considered in calculating the detection probability of a search radar?*

5. *What is the effect of atmosphere turbulence on high gain antenna performance?*

6. *How is the sidelobe level of a radar antenna effected by random perturbations of phase and amplitude over the aperture?*

7. *How does the AGC bandwidth effect the accuracy of angle-tracking?*

If you believe that you can assist us in the solving of these problems, please write:

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E. F. Culverhouse
175 Great Arrow Ave.
Buffalo 7, N. Y.

WALTHAM LABORATORIES
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Your inquiries will be answered within 2 weeks.

SYLVANIA
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ENGINEERS

PARTS APPLICATION
(Reliability)

ME or EE degree with design experience and/or application experience. Job will be to recommend types of parts to be used and how these parts shall be used.

Qualified men will become a vital part of a Reliability Group.

GM INERTIAL GUIDANCE SYSTEM PROGRAM

• ELECTRONICS DIV., Milwaukee 2, Wis.

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To aid you in your professional advancement AC will provide financial assistance toward your Master's degree. A Graduate Program is available evenings at the University of Wisconsin, Milwaukee.

GM's Electronics Division aggressive position in the field of manufacture and GM's long-standing policy of decentralization creates individual opportunity and recognition for each Engineer hired.

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Milwaukee offers ideal family living in a progressive neighborly community in cool, southern Wisconsin where swimming, boating, big league baseball and every shopping and cultural advantage is yours for the taking.

To arrange personal, confidential interview in your locality send full facts about yourself today to

Mr. John F. Hoffinger
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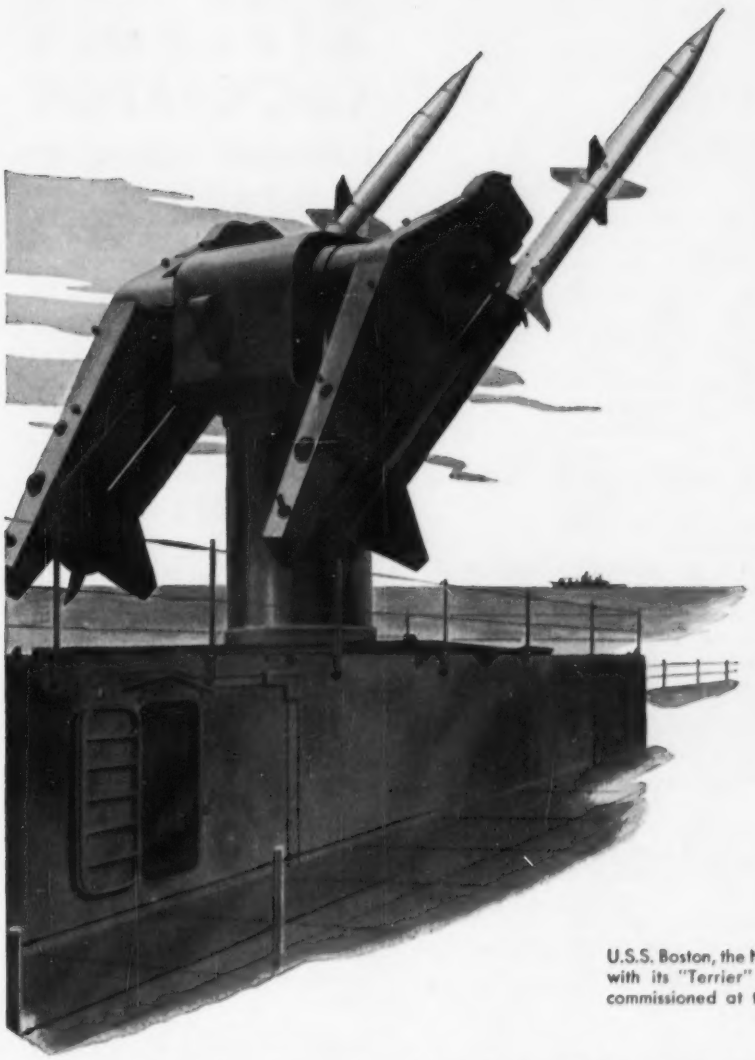
AC

Electronics Div.
General Motors Corp.
Milwaukee 2, Wis.

EMPLOYMENT OPPORTUNITIES

"TERRIER" -ready for action!



U.S.S. Boston, the Navy's first guided-missile ship with its "Terrier" ready for action, as it was commissioned at the Philadelphia Navy Yard.

ONE OF THE MOST potent defense weapons now in use by our Navy is a supersonic, rocket-propelled, guided-missile called the "Terrier". Well named, the job of this electronically-controlled "watchdog" is to track down an enemy and put him out of action *before* he can strike.

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From the first sketch to the final, super-accurate mechanism, Philco pioneered and completed this assignment in cooperation with the Navy. Philco's world famous scientific knowledge and skill is a continuing factor in the development of tomorrow's defense for your protection . . . tomorrow's quality products for better peacetime living throughout the world.

PHILCO is Currently Engaged in Long Range Industrial and Diverse Military Engineering Fields

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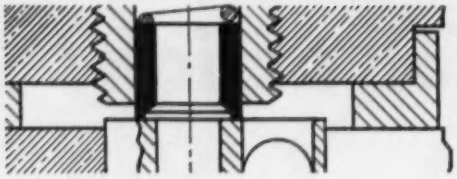
Philco offers a wealth of career opportunities for qualified engineers

PHILCO CORPORATION

Government and Industrial Division, Philadelphia 44, Pennsylvania



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Continually expanding programs at Northrop Aircraft are creating new opportunities for mechanical engineers in the following areas: launching and landing gear design, hydraulics and pneumatics, control systems, and equipment.

You'll enjoy the fine spirit of cooperation at Northrop. The new multi-million-dollar engineering and science center, now nearing completion, will be a great place to work in, both as to its modern architectural design and newest scientific installations. You'll be associated with a top engineering team on such notable projects as Northrop's new supersonic trainer airplane, Snark SM-62 intercontinental missile, and other advanced aircraft and missile programs.

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At Northrop, the progress of personnel is important. Initiative and ability are recognized and encouraged, and full opportunity is given to present and discuss ideas.

You will find the career opportunity you are seeking at Northrop, pioneer in the design and production of all weather and pilotless aircraft. If you qualify for one of these attractive positions, contact the Manager of Engineering Industrial Relations, Northrop Aircraft, Inc., ORegon 8-9111, Extension 1893, or write to: 1015 East Broadway, Department 4600-T Hawthorne, California.

NORTHROP

NORTHROP AIRCRAFT, INC., HAWTHORNE, CALIFORNIA

Producers of Scorpion F-89 Interceptors and Snark SM-62 Intercontinental Missiles

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Modern schools.
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the year 'round.

This modern laboratory is the Western Division of the well-established Aerophysics Department of the Goodyear Aircraft Corporation of Akron, Ohio.

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Openings are available for experienced personnel and recent college graduates.

Complete Missile and Electronic Systems
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Modern Inexpensive Housing

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A. E. Manning
Engineering and Scientific Personnel

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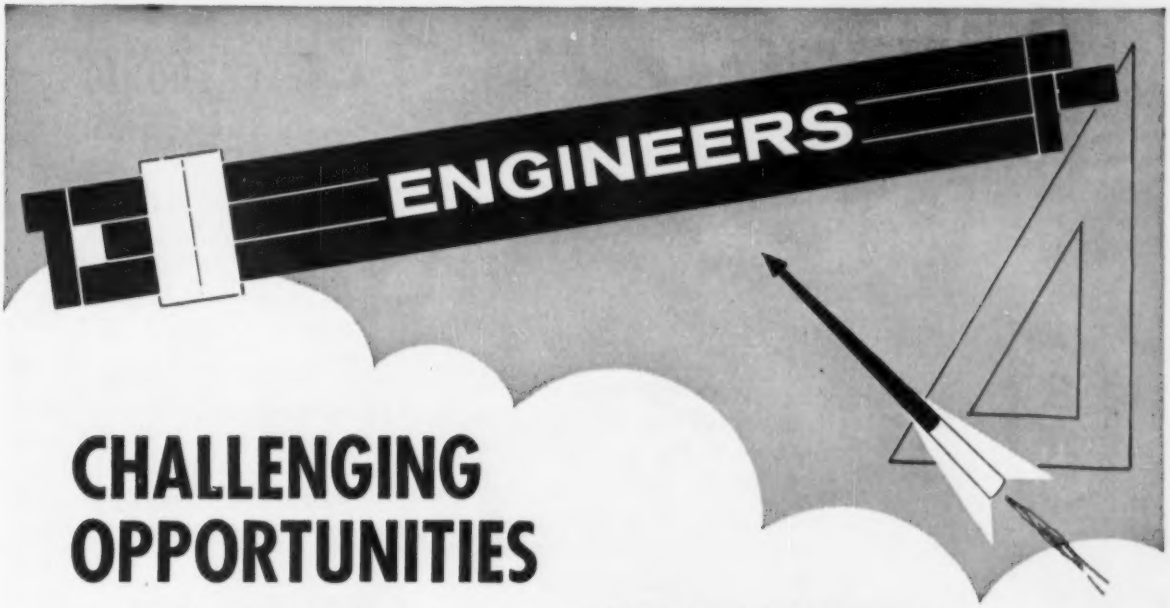
LITCHFIELD PARK
PHOENIX, ARIZONA

Similar opportunities available in our Akron, Ohio Laboratory



CHALLENGING OPPORTUNITIES

IN
- **Avionics**
- **Computers**
- **Jet Engine Fuel Controls**
- **Inertial Systems**
- **Missile Guidance**

WITH AC THE ELECTRONICS DIVISION OF

General Motors

ALL GRADUATE ENGINEERS are offered permanent job opportunities. We extend a cordial invitation to every deserving Engineer and Designer to write us their wants. We may be able to supply the square hole for the square peg!

YOUR FUTURE depends on your making the right connection with the right firm as quickly as possible.

The men hired will enjoy working with some of the top men in the field and with the finest test, research and development facilities. GM's long-standing policy of decentralization creates individual opportunity and recognition.

Why not send us full facts about your education, work background, etc. We will do all we can to treat your application with the fullest confidence.

AC SPARK PLUG — THE ELECTRONICS DIVISION
GENERAL MOTORS CORPORATION
MILWAUKEE 2, WIS. — FLINT 2, MICH.

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...an established concept at Convair-Pomona where your opportunities in the career of your choice are virtually unlimited. Work in the finest engineering facility in the country at America's first exclusive Guided Missile plant. Ultra-modern surroundings, completely air-conditioned, in beautiful Pomona only minutes from Los Angeles, the mountains, the seashore or desert recreation. Here is country living near the city at its best:

Excellent opportunities available now in:

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DYNAMICS
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Dept. 3-G

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CORPORATION
POMONA
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**Positions located throughout USA*

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ELECTRONICS *Plus*

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electronic engineers

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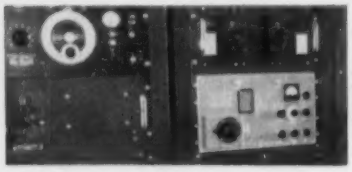

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OR for additional technical information, contact Mr. D. R. Barker *or* Mr. H. R. Holloway
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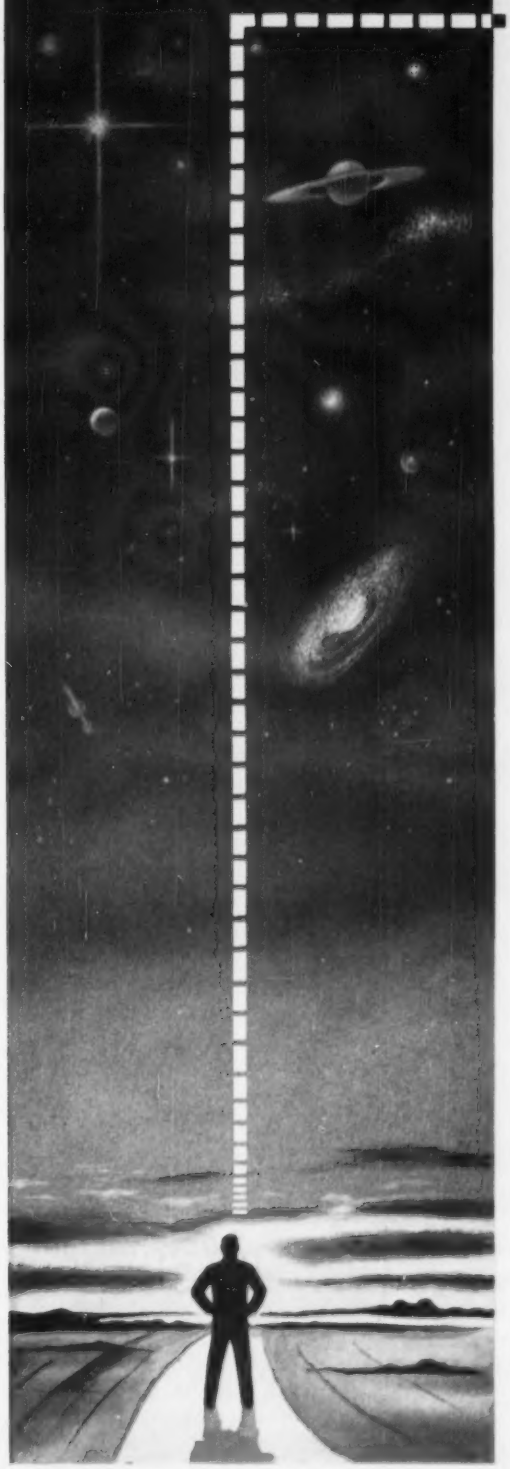
ELECTRONIC ENGINEERS



Consider the significance of your profession!

The shape of things to come is being designed by electronic engineers of professional stature, the exceptional engineers who—by education and experience—are qualified to fulfill an important destiny. Such men are needed at Bendix Radio to do research and development on the most advanced electronic systems in both military and commercial fields.

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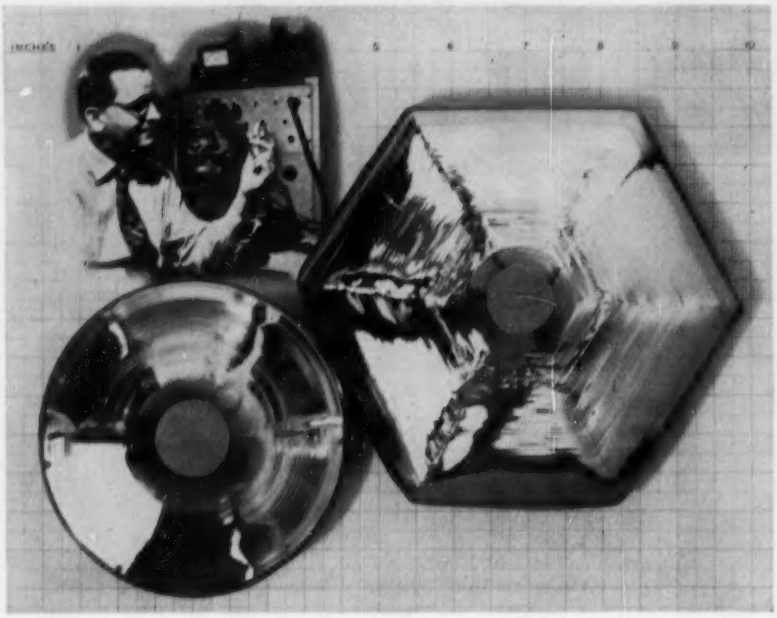
Radio

engineers / physicists . . .



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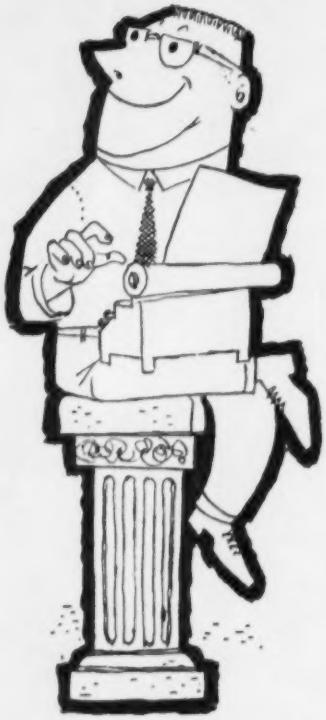

. . . if you're one of them, let us tell you about the opportunities for publications engineers at Collins . . .

In the fields of . . .

Microwave Relay	Flight Control
Navigation Systems	Radar Systems
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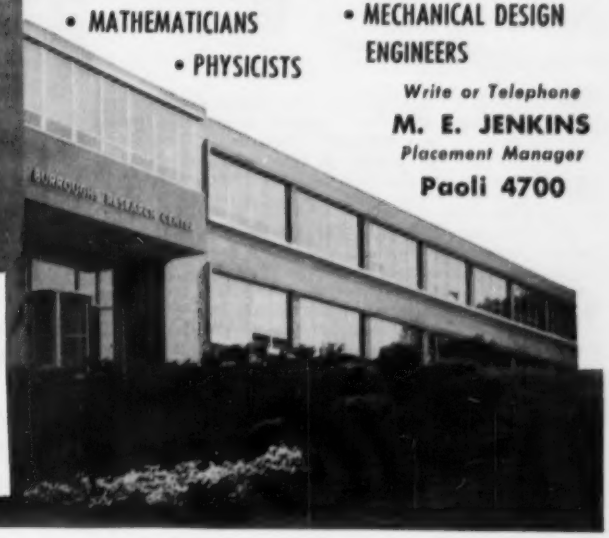

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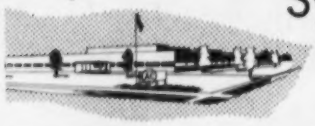
Servo Engineers

ELECTRICAL MECHANICAL
Inertial Guidance System Program



Enjoy Challenging Opportunities in the further development and systems testing of Inertial Guidance Systems and their Servo Loops in the most versatile laboratories in the country.

Work with the top men in the field and with the finest test, research and development facilities. New plant being added in suburban Milwaukee as a part of Major, Permanent, Expansion Program.

AC will provide financial assistance towards your Master's Degree. A Graduate Program is available evenings at the University of Wisconsin, Milwaukee.

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Milwaukee offers ideal family living combining small town hospitality with every metropolitan shopping and cultural advantage.

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The Operations Research Office of The Johns Hopkins University offers exceptional opportunities for scientists who prefer the challenge of operational problems of unusual scope and diversity to routine design and development work.

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- Determining applications of known photographic, accoustic, infrared and radar techniques to military problems
- Military communications systems planning, analysis and evaluation
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Research Personnel Officer

THE OPERATIONS RESEARCH OFFICE

THE JOHNS HOPKINS UNIVERSITY
7100 Connecticut Avenue
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An Engineer and his Family Enjoy Life in Upstate New York

where he is associated with the

Electronic Tube Division of WESTINGHOUSE ELECTRIC CORP. Elmira, N. Y.

Engineers change jobs for many reasons. Here is a typical example of the reasons why many engineers have selected the Westinghouse Electronic Tube Division in Elmira, N. Y. as the place to advance their engineering careers, and why they like the Elmira area as a place for pleasant family living:

"It took me several years to realize that selecting the right job in the right location is really a "family affair". Unless the wife and kids are happy, too, there's not much sense in sticking with a job . . . no matter how interesting the work is.

"About year ago, we decided that 'big city' life was not doing our family any good. Marge had made a few good friends, but didn't feel she had grown 'roots'. Our two youngsters, Billy and Linda, were nervous and high-strung . . . with no good place to play. My salary was pretty fair, but the high cost of city living ate it up quickly.

"That's when I started looking around for an opportunity that would enable us to live in more congenial surroundings. We checked into several offerings, but none seemed to suit us.

"Then I saw an ad for openings in the Westinghouse Electronic Tube Division in Elmira, N. Y. It sounded like the kind of work I wanted, so I phoned Bob Jarrett, the employment supervisor, and arranged for an interview. That was our lucky day!

"After traveling to Elmira and talking with Mr. Jarrett, I found that my E.E. degree and previous experience qualified me for a position in the Camera Tube Design Section. With a little instruction, I could qualify for several other jobs, too.

"Mr. Jarrett explained about the Westinghouse pension and insurance plan. It was the kind of protection I needed for my family.

"He also told me there would be a 3% general increase in salary each Fall for the next three years, quarterly cost of living adjustments, and periodic review of my work to determine merit increases. Because the Electronic Tube Division is new and expanding rapidly, the chances for promotion are unusually good.

"I liked the looks of the clean little city, the attractive residential areas, and rolling wooded hills all around. About a mile from the plant, I spotted a super golf course!

"When I asked Bob Jarrett about outdoor activities, he said there was wonderful fishing, boating and swimming in the Finger Lakes, about 25 to 30 minutes' drive. (Lots of Westinghouse folks have summer cottages there and commute to work).

"Well, to make a long story short, I received an offer through the mail in a few days that seemed mighty attractive. When I took Marge and the kids to see what Elmira was like, they fell in love with the place!

"My work at Westinghouse this past year has been richly rewarding. Plenty of design problems to challenge my engineering training and experience. Working together as a team, my colleagues and I are making significant contributions in the field. I'm finally advancing my engineering career.

"As for Marge and the kids, let her tell about that . . ."

"Well, like most engineer's wives, I'd be willing to live wherever Jim's work took him. But when Billy and Linda came along, it was different. I wanted them to grow up in a community where there were good schools, churches, and clean wholesome surroundings.

"When Jim accepted a position with the Westinghouse Electronic Tube Division and we moved to Elmira, I knew we had found exactly what we wanted.

"Everyone seemed so friendly and anxious to help us get acquainted. The folks at Westinghouse helped us locate a darling little home . . . only 6 minutes' drive from doorstep to plant!

"I was invited to join the Newcomer's Club . . . so I got acquainted quickly. And we were soon made to feel at home in one of the many churches.

"Elmira is large enough to have all kinds of organizations and cultural interests . . . community concerts, Little Theatre, camera club, bird-watching, bowling, sailing, hiking and bridge. Yet, it's small enough to be close to fields and forests.

"Jim seems so much more relaxed now. He's working hard at Westinghouse because he loves it, but here he can enjoy the things he was missing in the 'big city'.

"I've found many fine places to shop . . . modern department stores, super-markets, and everything! Our living costs are down, too. Jim grew a grand vegetable garden in our back yard . . . and I'm getting interested in raising flowers.

"Both the children have grown taller and huskier since we left the 'big city', and they've lost their high-strung temperament.

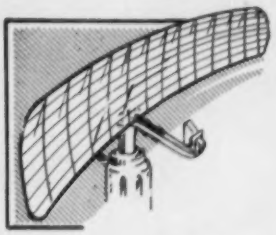
"This is real family living, and we are all growing 'roots' in the community, thanks to Jim's decision to work at Westinghouse."

If you are interested in advancing your career in the electronics field, we invite you to submit information which may lead to an interview. At present we have opportunities for engineers in Tube Design and Development for Microwave Tubes, Receiving Tubes, Pickup Devices, Power Tubes, Cathode Ray Tubes; Application Engineering, Electrical Equipment Design, Manufacturing Engineering, and Glass Engineering.

In submitting information concerning your background, phone collect to Westinghouse Electronic Tube Division, Elmira 9-3611 and ask for Robert M. Jarrett. (After 5 p.m. or weekends, phone collect Elmira 9-2360). If you prefer, write a letter to Mr. Jarrett, Dept. Q-22, giving basic information, and ask any questions you wish.

RAYTHEON

RADAR



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Radar Professional Personnel, 242—Raytheon Mfg. Co., Wayland, Mass.

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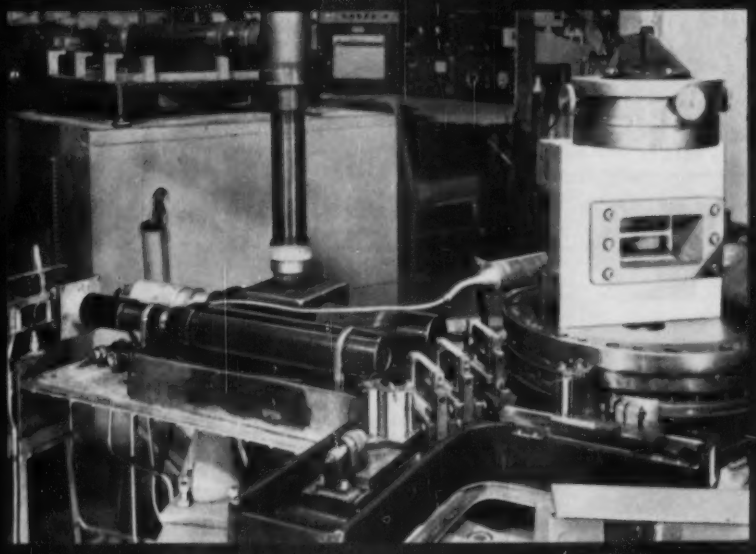
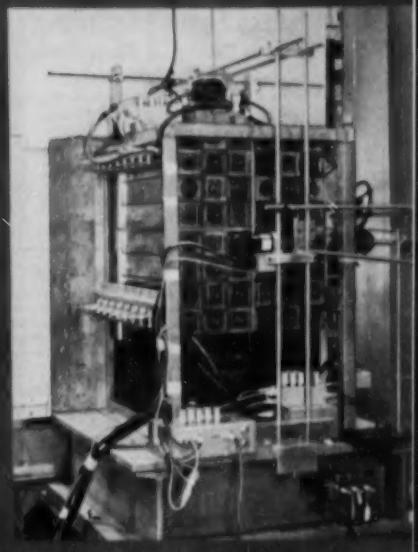
P.S. We are also interested in M.E.'s, Physicists and Experimentalists.



BASIC RESEARCH
The crystal table and the optical system of the 7.7 meter bent crystal gamma-ray spectrometer.

ENGINEERING DEVELOPMENT
Argonne National Laboratory Fast Exponential Assembly showing 5:1 ratio, 10 fuel plates and 5 dilution plates per fuel can.



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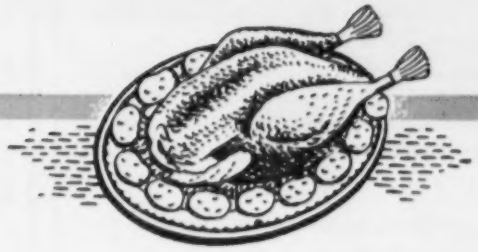

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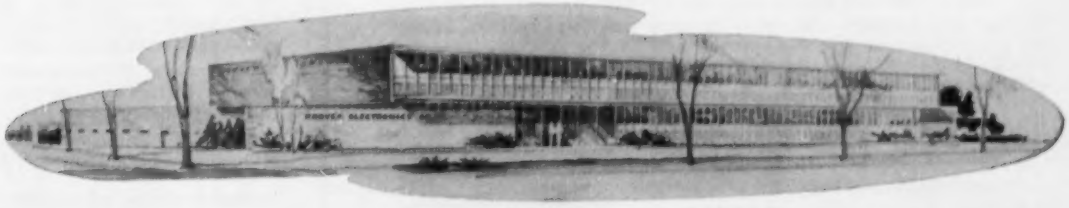

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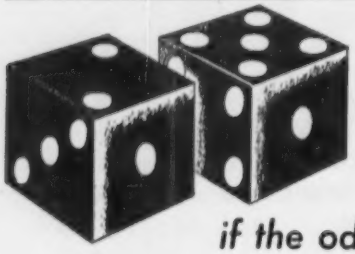

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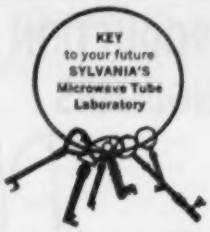

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BK29D	Q	WE-315A	10.00	WE-703A	1.25	WE-403A	1.50	725A	3.00	5704	1.60
35T	3.00	WE-316A	.50	WE-704A	.60	WE403B/5591	2.75	726A	5.00	5718	3.00
D-42	40.00	WE323A	10.00	WE-705A	.75	WE-404A	12.00	726B	15.00	5719	2.50
RK47	3.00	WE-336A	5.00	706AY-GY	10.00	WE-408A	2.00	726C	15.00	RK-5721	150.00
V-50	75.00	WE-338A	5.00	707B	2.50	WE-412A	4.50	730A	7.50	5725/6AS6W	2.75
V-50XR	75.00					GL-414	63.00	750TL	35.00	5726/6AL5W	.60
HK-54	2.00					WE-416B	37.50	801A	.35	5744	1.90
QK57	Q									5749/6BA6W	1.25
QK-59	25.00									5750	3.00
QK-60	25.00									5763	1.30
RK-60/1641	1.25									CK-5787	4.95
RK-61	2.50									5814	.80
QK-62	20.00									5814WA	4.00
HY-65	1.00									5819	35.00
RK-65/5D21	7.50									5825	7.95
FG-67	12.00									5829	1.00
HY-69	2.25									5837	50.00
RKR-72	.50									5840	4.50
RKR-73	.50									5841	6.00
ML-100	50.00									5844	1.50
100TH	6.50									5851	4.00
WE101D	3.00									5852	6.00
FG-105	11.00									5876	8.00
F-123A	2.50									5879	1.25
F-128A	10.00									5893	9.00
FG-154	10.00									5896	5.00
VT158	9.75									5899	5.00
FG-166	6.75									5902	5.50
FG-172	20.00									5902A	5.50
QK-181	25.00									5906	11.00
HF-200	12.50									5915	.80
WL-200	75.00									5932	4.00
204A	25.00									5933/807W	5.00
205F	6.00									5956	35.00
207	75.00									5965	1.50
211/VT4C	.50									5977	4.75
212E	15.00									5981	70.00
WL-218	15.00									5982	149.50
QK221	150.00									5987	9.50
FG235	60.00									5993/TE-10	9.00
QK235	Q									6005/	
QK-243	50.00									6AQ5W	1.95
QK-249	150.00									6021-A	6.00
WE245A	6.45									6028/408A	2.00
WE-249B	2.50									6037/QK243	75.00
250-R	3.50									6044	15.00
250TH	21.00									6046	.75
250-TL	12.50									CK-6050	2.00
WE-251A	49.50									6081/	
WE-252A	7.50									ATR407	22.50
QK253	Q									6082	4.00
										6096	1.50
										6099	1.40
										6100/6C4WA	2.25
										6111	6.00
										6112	6.50
										6116	150.00
										6130	7.50
										6136	2.50
										6147	3.00
										6159	3.00
										6177	49.50
										6189/	
										12AU7WA	3.00
										6201/	
										12AT7WA	2.75
										6203	2.75
										6205	6.00
										6211	1.50
										6246/508	200.00
										6254	13.00
										VA-6310/	
										V260	75.00
										8002R	15.00
										8012	1.00
										8025A	2.00
										9001	.85
										9002	.55
										9003	1.00
										9005	1.50
										D178461	50.00

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5" DUAL GUN TUBE

Long persistency face, P7 screen. Value at $200.00. This tube has been rejected for military use.

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6 mmfd. 32 KV... 8.00
50 mmfd. 32 KV... 8.00
75 mmfd. 20 KV...10.00
100 mmfd. 20 KV...12.50

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4X150G	10.00	828	7.50
4-65A	10.00	829B	15.00
4-65A	10.00	832	7.50
4-125A	10.00	833	30.00
4-400A	50.00	836	1.50
5AS	1.00	837	5.00
100TH	7.50	845	17.50
203A	1.00	849	15.00
250TH	30.00	860	15.00
304TL	10.00	861	275.00
350	275.00	864	7.50
371A	10.00	865	250.00
446A	1.00	872A	1.50
450TH	50.00	889RA	100.00
707A	10.00	1000T	75.00
715B	150.00	1603	4.75
715C	150.00	1611	2.50
	$765	1.15	

THYRATRONS

C1K	$5.75	FG-32	$ 5.75
2050	1.00	FG-105	10.00
2050W	1.00	FG-164	10.00
2D22	1.00	FG-172	10.00
3C45	1.00	FG-171	10.00
4B15	5.00	KU-627	10.00
4C35	1.00	5D21	1.00
4J120	1.00	5563	1.00
4J130	1.00	5663W	1.00
4C27	25.00	5663W	1.00
C6W/5520	7.00	2051	1.00
	$520/C6L	10.00	

5,000 SERIES & UP

5517	$3.00	5798A	POR
5528/C6L	10.00	5814	4.75
5559	12.00	5814WA	7.25
5560	125.00	5829	4.00
5586	POR	5844	2.00
5587	250.00	5845	2.00
5590	15.00	5847	1.50
5613	45.00	5854	1.50
5633	5.00	5876	11.00
5637	3.00	5886	7.50
5638	3.00	5886A	5.25
5639	3.00	5887	7.50
5640	3.00	5889A	7.50
5645	7.50	5892	4.75
5646	5.00	5892A	4.75
5647	5.00	5932	4.00
5654/6AK5W/	.50	5946/1754	200.00
6005	5.00	5955/1907	65.00
6057	125.00	5957	15.00
6059	7.50	5958	15.00
6072	3.00	5959	4.00
6076WA	4.50	5977A	3.75
6080	1.00	5978	5.00
6081	1.00	6005	1.75
6082	1.00	6006	1.75
6083	1.00	6021	4.50
6084	1.00	6032	POR
6085	1.00	6044	30.00
6086	1.00	6046	3.00
6087	1.00	6047	1.75
6091	1.00	6077	3.75
6092	1.00	6080	2.00
6093	1.00	6096 CT	2.00
6094	1.00	6100	2.25
6101	1.00	6101/6JGWA	4.25
6102	1.00	6110	2.00
6103	4.00	6112	6.75
6126 Klys	250.00	6136	5.00
6127	5.00	6137	5.00
6145/6AS6W/	.60	6152	POR
6146	4.00	6161	60.00
6175/6AL5W/	.50	6162	5.00
6907	3.00	6201	3.00
6912	3.00	6211	3.00
6939	3.00	6216	250.00
6940	3.00	6265	11.00
6950	1.75	6293	POR
6952	1.00	6294	POR
6953	1.00	6328	POR
6962	125.00	6354 Phot.	
6973	1.15	Mult.	40.00
6980/WE		6357 Phot.	
MAC	300.00	Mult.	8.50
6981	4.50	6362 Phot.	
6981/WE	3.00	Mult.	30.00
6984	4.00	6805	5.00
6984WA	7.50	6920/166R	7.50
6987	4.50	6952	4.00
6994	2.00	6957	1.15
6997	6.50	9006	.45

RECTIFIERS & REGULATORS

5R	$2.00	5Y3WGT	$1.50
5C	1.50	6-4	1.00
0B2	.75	6-7	1.00
0D3	.75	6-12	1.00
0G3	.50	7H4B	1.00
0Z4	.50	100W/8020	1.00
1V	.50	1001G	2.50
2X2	.50	250R	2.00
2X2A	1.75	714A	8.00
3B2A	1.75	871A	5.00
3B24W	1.00	816	1.00
5AR4	2.00	866A	1.50
5AGY	2.00	872A	1.50
5AWGY	4.00	876	.75
5Y1GT	.44	878	.50

MAGNETRONS

2J32	$4.50	4J38	$100.00
2J36	4.50	4J50	150.00
2J37	4.50	4J54	200.00
2J38	10.00	4J55	100.00
2J45	10.00	4J60	75.00
2J46	40.00	QK58	22.50
2J61	12.00	QK62	27.50
2J62	12.00	QK268	10.00
4J31	50.00	724C	15.00
4J32	50.00	725A	10.00
4J34	15.00	725B	15.00
4J35	15.00	725C	150.00
4J42	15.00	5087A	150.00
4J50	60.00	5780	300.00

SCOPE TUBES

3AP1	$4.00	5CP1A	$7.50
3AP1	7.50	5CP11	7.50
3CP1	5.00	5FP7A	3.50
3DP1	6.00	5JP1	15.00
3DP1A	10.00	5JP1A	25.00
3FP7	3.00	5JP1A	25.00
3JP1	7.50	5UP1	2.00
3JP7	7.00	7CP1	2.00
3WP1	80.00	7UP7	12.00
5AP1	5.00	9DP1	10.00
5BP1A	5.00	12DP7	12.00
5BP4	5.00	902P1	2.00

COMPUTER TUBES

2G21	$2.00	5654	$1.00
6AN8	2.25	6965, ETC.	1.00
	6253	1.85	

DIODES

1N21C	$12.00	1N32	$8.00
1N23B	1.50	1N50	.60
1N25	3.00	CK706	.40

W. AND WA. TUBES

6AC7W	$2.00	6J4WA	$3.50
6AC7WA	4.00	6SN7W	1.20
6AN8WA	2.75	6SN7WGT	1.50
6AQ8W	1.70	6SR7W	1.00
6AS6W	2.75	12AT7WA	1.50
6BF7	1.25	6X4W	1.20
6BF7W	2.50	6X8WGY	1.40
6J4	1.50	7F8W	2.00

MISCELLANEOUS POWER TUBES

2C42	90.00	YT-108R	POR
2C43	8.00	ML-172	$10.00
2C46	6.00	RY-434	25.00
2E29	8.50	892A	18.50

KLYSTRONS

SRX-16	$169.50	6BM6A	$37.00
2K25	18.50	2K55	15.00
2K26	27.50	2K50	150.00
2K39	27.50	4K35	150.00
2K45	40.00	V-45	POR
2K48	80.00	V-50	POR
2K54	15.00	V-52	POR
2K56	32.50	5651	40.00
6BM6	32.50	6136	250.00

TR. AND ATR. TUBES

1B27	$10.00	1B58	$42.50
1B35	4.25	1Q22	70.00
1B35A	7.00	GA4	2.50
1B40	2.00	832A	3.00
1B63A	20.00	6252	60.00

All items F.O.B. Los Angeles, subject to prior sale and change of price without notice

V & H RADIO and ELECTRONICS

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Gigantic SURPLUS SALE

ARMY GEIGER TUBE

• Finest beta-gamma precision radiation detection tube. Makes ultra sensitive uranium prospector Geiger Counter unit worth $100.00. Full instructions for constructing efficient counter-detector using tube plus few inexpensive components.
Cost $8.80 SALE **$1.39** Ppd

ULTRA-VIOLET (Black light) TUBE

• Conduct fascinating fluorescent glow experiments with this tube in your home laboratory. Operate on 110-v thru resistor. Full instructions. Rocks and minerals glow brilliantly under black light. Locate valuable mineral deposits.
Cost $2.50 SALE, **49¢** Ppd.

LARGE AC SELSYNS

• Finest large 110-v 60-c powerful Selsyns. Marvelous for experimental use. Make wonderful wind direction weather units. Transmit mechanical motion electrically, thus on small AC generators, etc. Many uses. Size 4"x6". Wt. 6 lbs. each. Runs directly off 110-v 60-c. Govt. cost $79.50 each.
SALE, **$15.41** per pair Ppd. or **$8.00** each.

SPECIAL OF THE MONTH!

POWER RECTIFIER

• New G.E. 115-v 60-c selenium rectifier unit. Will supply DC voltage for laby. work, signaling, power supply systems, experiments, radio and TV test benches, etc.
• Furnishes pure, well filtered direct current adjustable from 25 to 210-v. Also AC voltage adj. from 50 to 230-v. Attractive cabinet. Rough and fine adjustments.
Govt. Cost over $200 ..... SALE **$15.61** F.O.B.

BOAT & TRUCK ELECTRIC WINCH

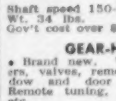
Operates from 6 or 12-v battery over 1000-lb. capacity
• Powerful expensive fully reversible Govt. ball bearing motor with built-in 100-to-1 ratio precision reduction gear. Gives smooth powerful pull on winch cable.
• Hundreds of applications. Mount on boat trailers, boat docks, raising anchors, etc.

• Ideal for trucks, farm equipment trailers, industrial uses. Lifts labor loading costs 90%. Wt. 54 lbs. 17"x12"x8". Drum holds 40' ¼", or 75' 3/16" cable. Orig. Govt. Cost over $200.
F.O.B. Lincoln **$46.71**

SURPLUS CENTER BUYS (Prepaid)

- Gear Reduction Unit 35 to 1 ($66) **$6.91**
- Govt. Weather Unit ($125) **18.71**
- 6-Volt Electric Winch ($250) **46.71**
- Power Plants (110-v 60-c 1000-W) **149.50**
- Weston 0-100 Amp DC Meter **9.71**
- G.E. 0-300 Amp DC Meter **8.80**
- Triplett 0-15 Amp DC Meter **3.91**
- Triplett 0-50 Volt DC Meter **3.96**
- Simpson 0-120 M.A. RF Meter **9.91**
- Westinghouse 0-35 M.A. DC Meter **3.91**
- G.E. 2100-Q KVA Variac (FOB) **39.20**
- Handset Holders Screw on desk ..... **.91**
- Edwards AC-DC Bell ($3.75) ..... **.79**
- Laboratory Sensitive Relay ($11.50) **2.37**
- Relay Spring Adjusters ($2.50) ..... **.97**
- Relay Gram Gauge ($7.50) **2.97**
- Machinists Calipers, polished, stainless **2.94**
- Telephone Line Test Phone Unit ($250) **24.95**
- 110-v to 200-c Telering ($70) **9.91**
- Federal Dual Amplifier-Repeater ($150) **19.76**
- Wire Chiefs Test Board ($175) **30.72**
- A.E. Step-by-Step Switch ($105) **19.89**

PERSONNEL CARRIER MOTOR



• Amazing buy! Use for golf cars, factory personnel carriers, boys auto, and 1000s other uses.
• Powerful expensive ball-bearing gear reduction motor runs on any 6-v or 12-v storage battery. Powerful high torque. Shaft speed 150-300 rpm. Full instr. Easily reversible. Wt. 34 lbs.
Gov't cost over $200 ..... Sale **$19.45** F.O.B.

GEAR-HEAD MOTOR

• Brand new. Will operate air dampers, valves, remote boat steering, window and door locks, garage doors. Remote tuning, rotate antenna arrays, etc.
• 9000 rpm all ball-bearing motor driving a worm gear, rotary double shaft. Very powerful due to high (1000 to 1) reduction ratio. Output speed is 6-10 rpm. Will operate on 6 to 24 volts DC or 8 to 12 volts AC. Fully reversible.
• Has limit switches to control travel limit. Splined drive shaft ⅝" dia. Overall dimensions 9"x5"x4". Marvelous equipment buy. Govt. cost over $100.
SALE ..... **$8.72** ppd

WESTON INDUSTRIAL TUBE TESTER

• Elaborate expensive laboratory type tube tester. Model 0Q3. Test hundreds of types including industrial, home receiver, TV, etc.
• Attractive desk case 8"x12"x24". Three precision meters, rectifiers, etc. Works on 110-v 60-c. Full instructions. Slightly used—perfect. Wt. 38 lbs.
Govt. cost over $100 ..... SALE **$14.90** F.O.B. Lincoln

G.E. AMPLIFIER-RECTIFIER

• New 110-v 60-c electronic unit. Push-pull amplifier-rectifier. Useful in laby. control circuits. In A-C control application, voltage applied to input will produce a DC voltage for motor or relay operation at output. Ideal for study of Servo-Selsyn circuits, etc. 10¼"x 9¼"x5¼".
Govt. Cost over $150 ..... SALE **$6.96** Ppd

DIAL TELEPHONE

• Genuine Kellogg standard dial telephone. Will work on any modern system either as main phone or as remote extension phone.
• Completely self contained transmission circuit, signal bells. Easy to connect. Complete with cord.
List $30.50 ..... SALE, **$13.91** Ppd.

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SOLA Constant Voltage TRANSFORMER

End Fluctuating Line Voltage

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So, if you choose, use

Brand new in original wood box. 4 cu. ft. Ship. wt. 254 lbs. F.O.B. Pasco, Wash. Only $97.50

(EXPORTERS: Note choice of 50 cycles.)

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COMMUNICATIONS EQUIPMENT CO.

PULSE NETWORKS

G.E. #2E3-5-2000-50P2T. 6KV "E" circuit, 3 sections 5 microsecond, 2000 PPS 50 ohms impedance.....**$6.50**

G.E. #2E (3-84-810) (3-2-24-405) 50 P4T; 3KV "E" CKT Dual Unit; Unit 1, 3 sections, 0.84 Microsec. 810 PPS, 50 ohms Imp; Unit 2, 3 sections, 2.34 microsec. 405 PPS, 50 ohms Imp.....**$6.50**

H-616 10 KV, 2.2 usec., 375 PPS, 50 ohms imp..**$27.50**

H-615 10KV, 0.85 usec., 750 PPS, 50 ohms imp..**$27.50**

H-605: 25KV, "E" CKT. 1.5 usec. 400 PPS, 50 Ohms Impedance, 5 sections.....**$62.50**

7-5E3-1-200-67P, 7.5 KV "E" Circuit, 1 Microsec. 200 PPS, 67 ohms impedance 3 sections.....**$7.50**

7-5E4-16-60, 67P, 7.5 KV "E" Circuit, 4 sections 16 microsec. 60 PPS, 67 ohms impedance.....**$15.00**

7-5E3-3-200-67P, 7.5 KV. "E" Circuit, 3 microsec. 200 PPS, ohms, Imp. 3 sections.....**$12.50**

PULSE TRANSFORMERS

352-7150. Primary 50 ohms, Secondary 1000 ohms, 12000v, 12.0 Amp. Pulse; 1 or 2 usec, at .001 duty ratio. Fitted with magnetron well and bifilar winding for filament supply.....**$32.50**

MAGNETRON PULSE TRANS. #964: Prim. Imp. 50 ohms. 1600 v. pulse. Secondary Imp. is 1250 ohms, 12 KV pulse. Turns ratio sec: pri. is 7.5:1 Duty ratio is 0.001 at 1.2 usec. Bifilar winding 1.2A.....**$8.50**

RAYTHEON WX 4298E: Primary 4KV., 1.6 USEC. SEC. 16KV-16 AMP DUTY RATIO: 001 400 CYCLE P/L. TRANS. "BUILT-IN".....**$32.50**

WECO: D-163247 For Modulator of SCR 720.....**$22.50**

GE #K-2449A
Primary: 9.33 KV, 50 ohms Imp.
Secondary: 28 KV, 450 ohms.
Pulse length: 1.05/5 usec @ 635/120 PPS. PK Power Out: 1,740 KW.
Bifilar: 1.5 amps.....**$62.50**

GE #K-2748-A, 0.5 usec @ 2000Pps. Pk. Pwr. out is 32 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk Bifilar rated at 1.3 Amp. Fitted with magnetron well.....**$24.50**

K-2745 Primary: 3.1/2.8 KV, 50 ohms Z. Secondary: 14/12.6 KV 1025 ohms Z. Pulse length: 0.25/1.0 usec @ 600/600 PPS. Pk. Power 200/150 KW. Bifilar: 1.3 Amp Has "built-in" magnetron well.....**$32.50**

K-2461-A. Primary: 3.1/2.8 KV—50 ohms (line). Secondary 14/11.5 KV—1000 ohms Z. Pulse Length: 1 usec @ 600 PPS. Pk. Power Out: 200/130 KW. Bifilar 1.3 Amp. Fitted with magnetron well.....**$29.50**

K35J45—Pulse Inversion: PRI: 5 KV PK. Pulse Negative. Sec: Pos. Pulse, 4 KV; 1 usec. and .001 DUTY RATIO.....**$6.50**

54J318-1—3 wdgs Ratio: 1:1:1, 1.10 uh. /wdg. 2.5 ohms DCR.....**$3.50**

UTAH X-151T-1: Dual Transformer, 2 Wdgs. per section 1:1 Ratio per sec 13 MH inductance 30 ohms DCR.....**$5.00**

UTAH X-150T-1: Two sections, 3 Wdgs. per section, 1:1:1 Ratio. 3MH. 6 ohms DCR per Wdg.....**$5.00**

68G711: Ratio: 4:1 Pri: 200V, Sec. 53V, 1.0 usec Pulse @ 2000 PPS. 0.01 KVA.....**$4.50**

TRI049 Ratio 21 Pri. 220 MH. 50 Ohms, sec. 0.75 H. DCR 100 Ohms.....**$8.75**

K-904695-501: Ratio 1:1, Pri. Imp. 40 Ohm. Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec rise.....**$8.95**

MICROWAVE ANTENNAS

3 CM ANTENNA ASSEMBLY: Uses 17" paraboloid dish, operating from 24 vdc motor. Beam pattern: 5 deg. both Azimuth and elevation. Sector Scan: over 160 deg. at 35 scans per minute. Elevation Scan: over 2 deg. Tilt. Over 24 deg.....**$35.00**

3cm. Horn, 1" x ½", with twist and 180 deg. bend. With dielectric window.....**$22.50**

AT49/APR—Broadband Conical, 300-3300 MC, Type N Feed.....**$8.95**

Discone Antenna. AR 125 AP8. 1000-3200 mc. Stub supported with type "N" Connector.....**$14.50**

AS14A/AP, 10 CM pick up dipole assy, complete w/ length of coax and "N" connectors.....**$4.50**

AS-46A/APG-4 Yagi Antenna, 5 element array...**$22.50**

30" Parabolic Reflector Spun Aluminum dish 10¼/ Focus.....**$4.85**

AN/APA-12—Sector Scan adaptor for APS-2 radar—Complete Kit.....**$37.50**

LP-24 Alford loop, for use with glide-path transmitters (MRN-1), etc 100-108 mc.....**$32.50**

18" PARABOLIC DISHES, spun aluminum. Focus approx. 8 Inches.....**$4.95**

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Model JB-1 Hydrophone is a piezo-electric device using an array of 20 barium titanate cylinders enclosed in a rubber cylinder 46 inches L and 2¼ inches in diam. Sensitivity:—105 db/microbar relative to 1 v/microbar. Frequency response: 200-15,000 cps. Impedance 100-150 ohms. The response at rt. angles to axis is uniform over an azimuth of 360 deg. The Hydrophone may be operated at depths up to 1000 ft and temperatures of —1 deg. C. to 35 deg. C. ... **$52.50**

JAN TEST EQUIPMENT

TS 13/AP. Signal source 9305-9445 mc, 50 microwatts. Comes with a wavemeter, thermistor bridge power meter, and calibrated attenuator. Oscillator is a klystron type 723/a-b which may be internally (self-synch) or externally pulsed. Controls are provided for FM operation, variable pulse delay, pulse width and phasing. Operates from 115 v, 60-800 cps. New....**$375**

TS 235 DUMMY LOAD: Provides excellent impedance match for peak powers of up to 750 kw. at .001 duty ratio. Frequency range 400-4,000 mc. Complete with blower.....**$150**

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DM33A	28	7	540	.250	3.95
B-19	12	9.4	275	.119	6.95
			500	.050	
DA-3A*	28	10	300	.200	3.95
			150	.010	
			14.5	5.	
PE 73 CM	28	19	1000	.350	17.50
BD 89	14	2.8	220	.80	8.95
DAG-33A	18	3.2	480	.06	2.50
BDAR 93	28	3.25	375	.150	5.75

‡ Less Filter. * Replacement for PE 94.
† Used, Excellent.
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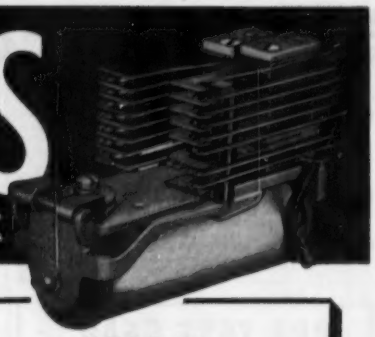

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DYNAMOTORS

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12	625	225	DM-35	9.95	
12	250	90	PE-133	4.95	6.95
12 or 24	540	450	DA-12		14.95
12 or 24	230	100	DA-24		8.95
14	220	70	DM-24	4.95	7.95
14	375	150	BD-83	3.95	4.95
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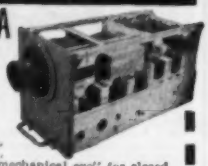

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1B73	2.25	815A	.60
1P28A	75.00	815GD	6.00
1P40	1.50	826A	5.00
1P40	1.50	826A	5.00
1P41	1.50	829A	7.50
1Y2	1.00	829B	7.50
1Z2	2.75	832	2.00
2A5/6A	1.50	836B	8.50
2B22	.70	837A	2.50
2C22	.70	837A	.70
2C24	.70	837B	1.50
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2C39	6.00	859A	6.00
2C39A	5.00	860A	2.50
2C43	9.00	WX860U	2.50
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2J48	35.00	701A	1.85
2J51	225.00	703A	1.75
2J52	40.00	705A	1.50
2J55	65.00	705C	12.00
2J56	15.00	706CV	12.50
2J67	220.00	707A	6.00
2K20	28.00	707B	6.00
2K24W	28.00	711A	.70
2K25	18.00	715A	1.50
2X2	.50	715B	.75
2X2A	.65	721A	.15
3A5	.55	721B	11.00
3B22	3.50	722	2.00
3B23	3.50	724A	.75
3B23	3.50	724B	.75
3B24	3.00	725A	3.00
3B24W	3.00	725B	4.00
3B28	3.70	750TL	40.00
3C22	6.00	800	.90
3C31	7.00	801A	.50
3C45	2.00	802	2.00
3D4/1299	.39	803	1.50
3D21A	6.50	807	1.20
3E29	6.00	811	3.38
3E34	6.25	811A	1.50
3E35	6.25	813	1.80
4C27	3.50	826	1.50
4C28	20.00	827N	110.00
4C35	20.00	829	6.00
4E27	6.50	829B	.90
4J22	200.00	836	.50
4J31	30.00	836	3.50
4J32	30.00	836	1.50
4X150A	25.00	837	.50
4X150G	84.00	838	1.00
5AS	2.25	842	1.85
5C22	14.00	845	.15
5D21	6.50	851	4.00
5J29	7.50	860	75.00
5AC7W	1.20	862	4.00
5AL5	1.45	866A	12.00
6AK5W	1.50	868	.30
6AR6	1.50	869	.75
6AS6	1.50	872A	.75
6AS7G	3.00	876	.75
6C4W	5.75	878	.45
6C21	3.00	879	.75
6C21	17.00	884	.60
6J4WA	1.50	889A	2000.00
6J6W	1.25	918	2.10
6SC7GTY	2.25	927	1.60
6SH7L	1.50	928	1.50
6SN7WGT	1.00	930	1.00
6SL7WGT	1.00	931A	.60
6SN7WGT	1.00	934	.60
7F8W	1.50	954	.60
12L6GT	.75	955	.60
12AT6T	1.50	CK1005	.50
12AU6	.75	E1148	.50
C1B	1.00	1201	.60
XF6T	2.00	1201A	.60
C1B	1.00	1231	1.00
1G	.70	1291	.60
1GV	.70	1294	.60
1K/CK615	.55	1299	.60
1SE	1.50	1613	.60
1SH	1.50	1620	4.50
T-2P	2.75	1625	.30
RX21	5.00	1626	.25
HK24G	5.00	1630	.30
HK24G/W	5.00	1631	.30
CE25A/W	3.50	1642	1.25
RK34	3.00	1643	1.50
35 SPECIAL	.70	1644	4.00
RK35	.60	1645	.60
REL36	3.00	1652P1	5.00
EF36	1.50	1900	.50
T55	5.00	1903	.50
QK58	22.00	1904	2.00
QK59	22.00	1905	.50
QK60	22.00	1906	10.00
QK61	22.00	1907	4.00
RK62	1.75	1613A	.60
RK63	7.50	1614	.60
RK72	2.00	1616	.60
FG81A	12.00	1621	1.50
VR91	1.65	1622	1.75
100TH	1.50	1623	1.00
114B	1.35	1624	1.00
149B	5.00	1625	1.00
FG166	55.00	1629	1.00
FG168	45.00	1710	1.00
203A	5.50	1744	5.00
211B	5.00	1754	5.00
211D	16.00	1774	1.74
218A	2.50	9814A	2.75

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01A	$ .75	6X4/6AGY	.60
02A	.60	6X5	.60
1A5	.67	6X5GT	.70
1A7GT	.85	6X8	.90
1B3GT	.85	6Y6G	.70
1C5GT	.85	6Z4	.60
1C6GT	.85	7A5	.60
1C7GT	.85	7A7/6C7	.60
1D5GP	.85	7B4	.60
1D8GT	.85	7B5	.60
1E5GP	.85	7B6	.60
1F4	.85	7B7	.60
1G3GT	.85	7B8	.60
1H4	.85	7C4	.60
1H5GT	.85	7C5	.60
1J6	.85	7C6	.60
1L4	.85	7C7	.60
1LC6	.85	7F7	1.50
1LD5	.85	7G7	.60
1LE3	.85	7H7	1.50
1LH4	.85	7Y4	.60
1LN5	.85	7Z4	.60
1P5GT	.85	12AH7GT	.60
1R5	1.45	12AT6	.60
1S4	.85	12AT7	.60
1S5	.85	12AU6	.60
1U4GB	.85	12AU7	.60
1V2GT	.85	12AV6	.60
1X2	.85	12AX7	.60
2A3	.85	12AZ7	.60
2A5	.85	12BA6	.60
2A6	.85	12BE6	.60
2A6GT	.85	12BA7	.60
2A7	.85	12BE7	.60
2AC7	.75	12BH7	.60
2AG5	.85	12BY7	.60
2AH5	1.45	12CG6	.60
2AL5	.85	12HG6	.60
2AP4	.85	12J5GT	.60
2AS6	.85	12J7GT	.60
2AV5GT	.85	12K5GT	.60
2B3GT	.85	12K7GT	.60
2B6G	.85	12SA7GT	.60
2B7	1.45	12SA7GY	.60
2B8	.85	12SC7	.60
2B8G	.85	12SF5GY	.60
2BC5	.85	12SG7	.60
2BC8	.85	12SH7GT	.60
2BE6	.85	12SJ7	.60
2BH5	1.45	12SK7GT	.60
2C4G	.85	12SL7GT	.60
2C5GT	.85	12SN7GT	.60
2C34	1.45	12SQ7GT	.60
2C46G	1.45	12SR7GT	.60
2D4	.85	12SW7	.60
2D8G	.85	12X4	.60
2E5	.85	12X7	.60
2E8	.85	12Z3	.60
2F8	.85	13BG6G	1.50
2F8G	.85	13C6	.60
2F8GT	1.45	13CG7	.60
2K7G	.85	13D6	.60
2K8G	.85	13V8	1.50
2L4	1.45	14A7	.70
2L6G	1.15	14AV6GT	1.15
2L6GA	.85	14BX6GT	1.04
2L7	.85	14L6GT	.60
2L7G	.85	14Z5	.60
2N7	.85	15	.60
2N7GT	.85	16	.60
2P5GT	.75	17	.60
2P7G	1.50	17L7GT	.60
2Q7GT	.85	18	.60
2R7	.75	19	.60
2S4	.60	19L6GT	.60
2S5	.60	19W4	.60
2SA7	.85	19Z4GT	.60
2SA7GT	.85	19Z5	.60
2SB7Y	.85	19Z6GT	.60
2SD7GT	.85	20/44	.60
2SF5	.85	21	.60
2SG7	.75	21Z6GT	.60
2SH7	.75	22	.60
2SJ7	.85	23	.60
2SJ7GT	.85	23Z6GT	.60
2SK7	.85	24	.60
2SK7GT	.85	25Z5	.60
2SN7GT	.75	25Z6	.60
2SQ7	.85	26	.60
2SQ7GT	.85	26L6GT	.60
2SR7	.75	27	.60
2T5	.75	28	.60
2T8	.75	30	.60
2V3GT	.85	31	.60
2W4GT	.85	32/6Z4	.60
2W6GT	.85	33	.60

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2AP1	$5.75	5CP1	6.00	7BP7	6.50
2AP1	5.00	5CP7	7.00	10CP7	6.00
2KP7	1.00	5FP7	2.50	14FP7	12.00
2KP7	1.50	5MP1A	14.00	902	5.00
5BP1	4.00	5LP1	12.00	902P1	5.00
5BP4	5.00	5NP1	12.00		

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1N21	$ .00	1N27	5.00	1N86	.65
1N21B	1.15	1N31	6.00	1N70	.65
1N22	1.15	1N32	15.00	1N91	1.15
1N23	.50	1N38	.75	CK706	.50

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Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AB/1A6	$1.99	OA2	.75	2K33	16.50	6BP1A	2.49	12AT7	.85	2748	1.79	700G	17.50	826	.75	1625	.29
CK1	1.25	OB2	.89	2K33	19.50	6BP4	2.95	12AU7	.89	276A	7.25	705A	35.00	829B	8.99	1626	.29
CL6	1.49	1A7G	1.59	2K36	29.50	6BP4	2.95	12CP7	12.95	276A	7.25	707A	5.50	830B	2.49	1628	.29
CS1	7.99	1B24	5.99	2K33A	59.95	6C12	25.00	12K8	1.25	282	7.25	707B	3.95	832A	5.00	1630	.29
CK-501AX/ 2K41	1.79	1B26	9.95	2K45	72.50	6CB6	1.49	12SH7	.49	286A	7.50	708A	2.99	833A	31.00	1641	.29
CRP RK-72	.49	1B35	1.98	2K45	32.50	6CF1A	12.00	26A7/GT	2.99	304TH	10.00	709A	2.00	837	1.50	1642	1.98
EC1	1.99	2A5/G	1.10	2K54	8.95	6CF2	6.00	26C5	1.10	304TL	13.50	713A	.95	838	1.50	1643	.29
EF-50	.29	2AP1	1.59	2K55	9.50	6CF2	6.00	28D7	.85	307A	1.85	714AY	24.95	841	1.50	1644	.49
EI148	.29	2AP1A	6.44	2V3/G	1.39	6CF3	6.00	35W4	6.25	310A	1.90	715A	2.45	842	16.50	1654PI	4.99
EM-1GA	20.50	3B27	1.99	2X2	.24	6CF4	6.00	36LF7	1.00	311A	1.90	715B	2.45	843	.49	2050W	2.49
F123A	5.99	3C21	.49	2X2A	.24	6CF5	6.00	38HE7	1.00	323A	4.49	715C	34.50	845	19.50	2051	1.98
FG117	6.50	3C22	.49	3A4	.89	6CF6	6.00	38K7	1.49	329A	4.49	717A	.49	860	19.50	2051	1.98
FG-105	12.99	3C24	.49	3AP1	5.95	6CF7	12.50	38LE7	1.00	347A	2.85	718A	24.45	861	19.50	2051	1.98
FG-154	14.99	3C24A	.49	3AP11A	4.95	6CL6	1.29	38Q7	1.00	348A	1.49	720C	.49	865	1.49	2051	1.98
HF-100	7.49	3C33	1.49	3B22	1.49	6CM7	1.49	41	7.25	354C	14.95	720C/DY/ EY	29.75	866A	1.19	2051	1.98
HK-24	1.49	3B24W	4.99	3B24	2.50	6CS6	1.49	42	7.25	368AS	1.49	721A	2.49	866JR/ 2B26	1.40	2051	1.98
HK-54	1.99	3B25	1.99	3B24W	4.99	6CU5	1.49	45	1.49	394A	2.99	721B	1.49	869B	30.00	2051	1.98
HY-65	1.49	3B27	1.99	3B25	1.49	6D4	2.99	50L6GT	.89	446A	1.19	721C	1.99	GL-872A	7.49	2051	1.98
HY-114B	.39	3B28	1.49	3BP1	2.99	6DE6	1.49	50Y6GT	.89	WL-417A	2.74	721A/B	6.50	873A	1.39	2051	1.98
HY-614	1.99	3C45	1.35	3BP1A	2.99	6DK6	.89	55	.89			724A	1.15	874	1.39	2051	1.98
HY-69	1.79	3C45	1.49			6DQ6A	1.49	56TH	4.95			724B	1.49	876	.39	2051	1.98

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	1N21B	.60	1N27	4.00	
	1N22	.50	1N34	.50	
	1N23A	.59	1N34A	.64	

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RK-34	1.99	3C22	2.49	3C22	44.50	203A	6.99	446A	1.49	726C	24.50	885	1.00	6875	1.25
RK-60	1.99	3C27	.99	3C23	5.99	205B	1.99	446B	1.79	728AY/BY/ CY/DY/ FY/GY	35.00	885	1.10	6876	1.39
RK-60	1.99	3C28	.99	3C27	5.99	205D	1.99	WL-460	8.99			902	1.00	6877	1.39
RK-61	3.80	3D21W	1.39	3C28	5.95	207	40.50	WL-464A	4.25	902P1	2.39	903	1.00	6883	2.10
RK-62/5D22	14.50	3D22	2.25	3C33	8.99	211	.72	730A	7.95	915	1.99	1006	.74	6886	2.00
RK-72	.49	3E29	4.00			212A	1.25	800	1.29	923A	2.99	1014	.74	6888	2.00
RK-73A	.49	3J31A	4.95	3C45	6.25	217A	2.00	801A	.42			1015	.74	6889	2.00
RK-73A	.49	3J32	4.00	3CP1	2.25	217C	4.00	802	2.49			1016	.74	6890W	3.00
VT25/1B	.57	3J33	5.00	3DP1	1.98	223A	1.25	803	2.49			1017	.74	6892	38.50
VT25A/10Y	.39	3J37	5.00	3DP1	1.98	233A	1.10	WL-530	19.50			1018	.74	6893	1.49
VT67/10 Spec	.39	3J50	14.50	3EP1	10.25	242C	8.00	WL-531	6.25			1019	.74	6894	1.49
VT-158	.57	3J51	14.50	3GP1	1.98	249B	5.99	832A	6.50			1020	.74	6895	1.49
VU-111	.39	3J52	13.50	3GP1	1.98	249C	5.99	866A/B/C/D/	.99			1021	.74	6896	1.49
1B32/832A	.99	3J53	13.50	3GP1	1.98	250TH	24.95	707W	1.25			1022	.74	6897	1.49
QK-59	29.50	3J55	14.50	3HP7	1.98	250TL	13.95					1023	.74	6898	1.49
QK-61	32.00	3J56	14.50	3J31	49.50	258H	1.99	701A	4.00			1024	.74	6899	.39
QK-105	90.00	3J57	14.50	4A-11	.20	259A	1.99	702A	7.25			1025	.74		
VR-21	.99	3J58	16.50	4C27	8.00	264A	1.99	703A	7.25			1026	.74		
VR-30	.72	3J59	16.50	4C28	35.00	264C	1.99	704A	1.50			1027	.74		
VR-105	.72	3J62	9.60	4CX1K	5.00	265A	11.00	705A	2.49			1028	.74		
VR-150	.79	3K22	14.50	4AP1	2.98	274A	5.95	706B	14.50			1029	.74		

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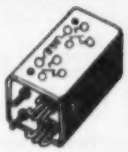

Light weight; Extremely small; Hermetically sealed in soder dipped brass can; 3 oz max weight. Silver contacts rated at 2 amp; soder lug connections.

22RJA200G: 10.0 ma operate, 3.5 ma release; 1A; 200 ohm; #R615 ..... **7.50* ea**

22RJCC5000G: 2.8 ma operate, 1.0 ma release; 2C; 5000 ohm; #R619 ..... **9.50 ea**

22RJCC8000G: 2.3 ma operate, 0.8 ma release; 2C; 8000 ohm; #R617 ..... **9.50* ea**

ALLIED 50G MH MULTIPOLE TYPES

Developed to meet spec MIL-R-575A; 18-30VDC; Hermetically sealed; —55°C to + 85°C; 50G for 11 milliseconds. Contact rating 2 amp. Solder lug connections.

MH18DT: 26.5 VDC; 6PDT (6C); 240 ohm; 4.2 oz; Operate time: 8 millisec, release; 5 millisec. Mounting plate opposite terminals; #R647 ..... **7.50* ea**

MH18D: Same as R647 above but mounting plate on same side as terminals (As illustrated); #R648 ..... **7.50* ea**

MH12D: 26.5 VDC; 4PDT (4C); 300 ohm; 2.9 oz; Operate time: 7 millisec, release: 5 millisec; #R649 ..... **7.00 ea**

MH6D: 26.5 VDC; DPDT (2C); 400 ohm; 1.3 oz; Operate time: 6 millisec, release: 5 millisec; #R665 ..... **6.00 ea**

STRUTHERS DUNN 220XFX100; (Similar to Allied MH18D); 26.5 VDC; 6PDT (6C); 240 ohm; 3 oz; #R1145 ..... **7.50* ea**

FILTORS, INC.

Developed to meet spec MIL-R-5757B; 4 to 9 VDC. Hermetically sealed; —65°C to + 125°C; 50G for 11 millisec; contact rating 3 amp. Solder lug connections.

6C9A: 6.3 VDC; 3PDT(3C); 42 ohm; 2.6 oz; #R669 ..... **6.50 ea***

268A12A: Developed to meet spec MIL-R-575A; same as Allied MH12D; 26.5VDC; 4PDT(4C); 250 ohm; 2.2 oz; solder lug header; #R670 ..... **7.00 ea***

STEPPING SWITCHES

SS5

Mfd. by Western Electric Minor Switch 10 steps and off Contacts: #'s R960, 975, 976 Gold plated brass; Bridging Wiper; other non-bridging; Net. Wt. 1 lb.

Step & Reset

	Each*
#R60; Single Level; 6 to 12 VDC	9.50
#R975; Single Level; 24 to 36 VDC	10.50
#R976; Single Level; 48 to 60 VDC	11.50
#R643; Single Level; 100 to 125 VDC	12.50
#R977; Two Level; 6 to 12 VDC	10.50
#R978; Two Level; 24 to 36 VDC	11.50
#R979; Two Level; 48 to 60 VDC	12.50
#R644; Two Level; 100 to 125 VDC	13.50
#R642; Three Level; 6 to 12 VDC	11.50
#R600; Three Level; 24 to 36 VDC	12.50
#R645; Three Level; 48 to 60 VDC	13.50
#R646; Three Level; 100 to 125 VDC	14.50

SS6 Mfd. by Western Electric Co.; 22 step; 5 levels; Bridging Wipers; Contacts; Gold plated brass. Interrupter Switch: 1 Break-Make; Net Weight: 2 lb. 2 oz. **"Homing" Type; 180° Wipers; Step in One Direction**

	Each*
#R926; 6 to 12 VDC	13.75
#R980; 24 to 36 VDC	14.75
#R981; 48 to 60 VDC	15.75
#R615; 90 to 130 VDC	16.75

SS7 Mfd. by Western Electric Co.; 44 step; 2 Levels; Bridging Wipers; Contacts; Gold plated brass; Interrupter Switch; 1 Break-Make; Net Weight 1 lb. 14 oz.

"Homing" Type; 360° Wipers; Step in One Direction

	Each*
#R927; 6 to 12 VDC	13.75
#R982; 24 to 36 VDC	14.75
#R983; 48 to 60 VDC	15.75
#R616; 90 to 120 VDC	16.75

CLARE TYPE 20 "Homing" type; Step in one direction; 20 position; 180° wipers, one bridging and remainder non-bridging; Interrupter Switch: 1 break, #R891; 24-36VDC; 3 levels; Clare #SD19 . . **12.95 each**

WESTON Model 705 SENSITROL

#R561

Stationary contact is a small powerful permanent magnet and movable contact is iron "rider" mounted on pointer which travels over relay scale. Operating torque moves pointer into magnetic field of stationary contact which draws movable contact and holds it firmly. Contacts remain closed until reset. Will operate directly from a photocell or a group of thermocouples. Net weight 14 oz.

Double contact with Solenoid Reset; Sensitivity 7.5 Microamps; Reset coil 6-24 VDC or 24 VAC; Makes contact on increasing or decreasing values; Contacts; "Twintacts", Capacity 100 ma at 110 volts; Nickel plated brass cover; Weston Model 705 Type 6 #560 ..... **18.75***

Same as #R560 but with glass face; Weston Model #705 Type 6 R561 ..... **19.75***

Single contact (Normally Open), Solenoid Reset; Sensitivity; 10 Microamperes; Reset coil; 6-24 V DC or 24 V AC; Contact: "Twintact", capacity 100 ma at 110 volts; Glass Face; Weston Model 705 Type 4 #R523 ..... **17.75***

Same as #523 with Brass Cover Weston Model 705 Type 4 R523N **16.75***

HERMETICALLY SEALED SPECIALS

ADVANCE A7979-1Y: 115VAC; 6PDT(6C), Dual 4½ Amp Contacts, Hermetically sealed; 20 pin standard plug-in base; #R1039 ..... **7.00* ea**

ADVANCE D8797-1Y: 24VDC; 4PDT(4C), 10 Amp Contacts, Hermetically sealed; Solder lug header; #R1040 ..... **6.00* ea**

ADVANCE A7974-1: 115VAC, 25 to 800 cyc; DPDT(2C), 10 Amp Contacts; Hermetically sealed; AN connector; #R1041 ..... **6.00* ea**

KURMAN TIME DELAY

R300, motor driven 110V 60 cycles; continuously adjustable delay 10 to 60 seconds; SPST(1A); #R671 ..... **7.95* ea.**

Prices listed with asterisk (*) are subject to QUANTITY DISCOUNTS

1-9	as quoted	50-99	15%
10-49	10%	over 100	20%

AN TYPE RELAYS

AN3303-1: 24VDC; 4PDT(4C); 200 ohm; Hermetically sealed; AN Connector; #R677 . . . . **7.00 ea**

AN3304-1: 24VDC; 4PDT(4C); 425 ohm; Hermetically sealed; Solder lug header; #R446 . . **6.00 ea**

AN3308-1: 24VDC; 3PDT(3C); 10 Amp Contacts; Hermetically sealed; AN Connector; #R1034 ..... **7.50 ea**

AN3310-1: 24VDC; 4PDT(4C); 10 Amp Contacts; 160 ohm; Hermetically sealed; AN Connector; #R1035 ..... **9.50* ea**

AN3312-1: 24VDC; 3PDT(3C); 10 Amp Contacts; 135 ohm; Hermetically sealed; Binding posts; #R1036 ..... **8.00* ea**

AN3316-1: 24VDC; 4PDT(4C); 10 Amp Contacts; 135 ohm; Hermetically sealed; Binding posts; #R1037 ..... **9.00* ea**

AN3316-2: 24VDC; 4PDT(4C); 10 Amp Contacts; 135 ohm; Hermetically sealed; Binding posts; #R1038 ..... **9.50* ea**

AN3350-2: 24VDC; SPST(1A); 50 Amp Contacts; 100 ohm; #R297 ..... **7.50 ea**

MAGNETIC CLUTCH

Double acting magnetic clutch; rated for operation on 24VDC; 125 ohms; 200 ma. Pulls in at 18 VDC, drops out at 5 VDC. Tooth clutch assures positive coupling. Torque capacity 12 in-lbs. An extra output shaft and a concentric flange are engaged with power off. When power is applied, flange disengages and shaft can rotate freely while coupling engages shafts through the unit. Flange can thus be used as a quick acting brake on output shaft.

Of ball-bearing construction, can operate at high speed. Suited for precision use as backlash and play are zero. Stainless steel output shaft 3/16 dia. x 1/2" long. Bronze input shaft 3/16 dia. x ⅜" long. Concentric flange, 1-5/8 dia. x 3/16 thick with 3 equally spaced tapped holes for coupling. Aluminum body 1-⅞ dia. x 2" long, exclusive of shafts. Mounting flange at output end. Shipping Wt., each 5 lb.

#MC101 ..... **$6.50* ea.**

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P.P.I. REMOTE REPEATERS

VD-7" Upright
VE-7" Table Type
VF-5" "B" Scope "G" P.P.I.
VG-"24" Plotting Table
VJ-12" Upright
VK-12" Upright
VL-12" Upright R.H.I. IND.
All indicators are 110v 60 cyc.

SHORAN

AN/APN-3-AN/CPN-2

The AN/APN-3 and AN-CPN-2 are Precision distance measuring installations. This equipment operates on 228 mc. The range is 250 miles with an accuracy of 25 feet. This equipment is widely used by geological companies for prospecting and mapping. Power input is 110v 400cyc and 28v DC.

AN/GSQ-1 NAVY TYPE PF SPEECH SCRAMBLER

This is a unit designed to be attached to either a radio or telephone circuit to scramble speech or code. This equipment utilizes coded cards in each terminal equipment. Unless the property numbered card is inserted on the receiving end the speech can not be unscrambled. This provides an excellent privacy system. 24 VDC input. Mfg. Western Electric.

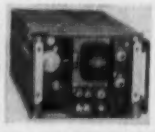
SCR-536 HANDI-TALKIE

Freq. range 3.7.5.5mc crystal controlled battery operated handi-talkie. The range of this equipment is approximately 2 miles. We can supply these sets to your specified freq. Completely reconditioned and guaranteed.

WE CAN SUPPLY OVER 1500 OF THESE SETS

AN/ARC-12

AIRBORNE 225-350 MC TRANSCEIVER



These sets provide 10 chan channel communication from 225-350 mc. A guard channel is also provided. The AN/-ARC-12 is a late set and is the V.H.F. version of the AN/ARC-1, and will communicate with the ARC-19, ARC-27, ARC-33 etc. Output is 8 watts. Input is 28 VDC.

AN/ASQ-1 AIRBORNE MAGNETOMETER

This is an airborne chart recording magnetometer. The set consists of an amplifier, oscillator, detector head, chart profile recorder, power supply. The equipment has a sensitivity of 2 gamma. The AN/ASQ-1 records on an Esterline angus recorder disturbance in the earth's magnetic field. An indicator is provided that gives a bearing on a magnetic disturbance. Input is 28v DC. Weight about 130 lbs.

AN/APR-4 Search Receiver

The AN/APR-4 receiver is a precision laboratory instrument covering 38-4000 MC in 5 plug-in tuning units. The tuning units are calibrated directly in megacycles. A wide or narrow band width I.F. may be selected in the receiver enabling pulsed signals to be observed. Outputs for a pulse analyzer; panadaptor, etc. are provided. A tuning meter is also provided. Input 110v 60 cyc.

CARRIER EQUIPMENT

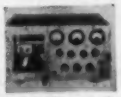
CF-1 4 CHAN. VOICE AND TELEG. TERMINAL 115v 230v A.C. 12v D.C.
CF-2 4 CHAN. TELEGRAPH AND TELETYPE TERMINAL 115v 230v A.C. 12v D.C.
CF-3 4 CHAN. INTERMEDIATE REPEATER 115v, 230 A.C. 12v D.C.
CF-4 CARRIER CONVERTER. Used to adapt the CF-1 and 2 for operation on a simple 2 wire trans. line instead of using spiral 4. 115v, 230v A.C. 12v D.C.

MISC. EQUIPMENT

AN/CPN-6 3 CM Beacon
AN/UPN-4 3 CM Beacon
AN/URC-4 VHF Rescue Set
AN/TRC-1, 2, 3, 4, 6, 7.
AN/GRC-9 Field Radio, many other AN equipts.
SCR-191, 300, 399, 499, 508, 608, 808, and others
TEST SETS from TS-1 to TS-700 many late types
PARTS SPARE and sets of equip mfg. after 1948. radar, radio and special types write

RDO

NAVY SUPER SEARCH RECEIVER



The RDO is a very elaborate radar search receiver greatly improved over the APR-4. The set uses APR-4 tuning units, but is much more versatile, having input metering, D.B. output meter, automatic noise limiter, and greater selectivity and sensitivity. The RDO is recommended when only the very best will do. Input 110v 60 cyc.

RC-115B GROUND 75 MC MARKER BEACON TRANS.

This is a 75 C Marker Beacon Ground Station. This equipment comes mounted in a transporting trunk. The set can emit either inner, outer, or airways signals. The transmitter is crystal controlled. 110 Volts 60 cyc. Late USAF equip.

TUBES

BRAND NEW—GUARANTEED—In Stock—95 % RCA GE Sylvania Tungsol Commercial JAN Boxed Bulk

Receiving Types															
1AG4	.62	12SG7	.65	5X4	.35	35Y4	.46	HF140	4.50	830B	1.25	1N58A	.32
1U4	.45	SPECIAL		6A8	.68	35Z4	.32	218	20.00	843	.25	1N86	.25
5Z4	.92	25L6GT (Tung-Sol Jobber Boxed) Late Date. @55c		6K7GT	.40	Transmitting Types		250TL	10.95	851	4.95	CANADIAN-MARCONI	
6AC7W	.75			6L7	.78			250TH	23.75	864	.23	Most Jobber Boxed 10c Special	
6AK6	.55	30	.35	6Q7	.72	1B32	.35	270A	37.50	865	.25	1B5	1F7G
6AN4	.69	70L7	1.10	WE BUY SURPLUS AT HIGHEST PRICES				446A	.32	902P1	1.50	1B7Gt	1G5G
6AS5	.47	5642	.72					450TL	45.00	958A	.39	1C6	33
6BQ7A	.89	Branded "Rogers-Canada" Many of US Mftre						468	12.00	1625	.29	1D7	36
6SK7	.48			7B6	.48	2C40	8.25	707A	1.50	1629	.26	1E5GP	38
6V6GT	.45			7C6	.52			722A	.35	5783	2.45	1F6	39
12AU6	.44	1A7	.44	7Q7	.62	5R4GY	1.10	725A	1.75	9002	.62	Also	
12AT6	.40	1LA6	.68	7Y4	.46	35TG	1.95	807	1.10	9003	1.35	1G4Gt	19c
12A6	.38	1S5	.42	14Q7	.58	90NB	15.00	807W/5933	1.95	AX9903/		1J6G	25c
12AY7	1.00	25Z6	.45	35L6GT	.49	HF120	3.25	808	.75	5984	18.50	3ABGt	25c
		1V6	.70					813	9.00	9004	.25	6BBG	35c
										Diodes		6R7	42c
										1N38A	.35	12A	12c
										1N54	.65	12Q7Gt	30c
										(Rated: D&B)		1st Quality—Canadian—Unbranded	
												1A4P	8c
										Many other types in stock.		1D5GP	20c
										Wholesale & Export Only		19	11c
												46	19c

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10042-1-A Bendix
DC input 14 volts; output: 115 volts; 400 cycles. 1-phase; 50 watt **$35.00**

12116-2-A Bendix
Output: 115 VAC; 400 cyc; single phase; 45 amp. Input: 24 VDC, 5 amps. **$35.00**

12117 Bendix
Output: 26 volts; 400 cycles, 6 volt amperes, 1 phase. Input: 24 VDC; 1 amp. **$15.00**

12121 Bendix
Input: 24 volt D.C. 18 amp. 12000 r.p.m. Output: 115 volts, 400 cycle, 3-phase, 250 volt amp. 7 pf. **$49.50**

12123 Bendix
Output: 115 V, 3-phase; 400 cycle; amps .5 Input: 24 VDC; 12 amp. **$49.50**

12126-2-A Bendix
Output: 26 volts; 3 phase; 400 cycle; 10 VA; 6 PF. Input: 27.5 volts DC; 1.25 amps. **$24.50**

12130-3-B Bendix
Output: 125.5 VAC; 1.5 amps. 400 cycles single phase, 141 Va. Input: 20-30 VDC. 18-12 amps. Voltage and frequency regulated. **$49.50**

12133 Bendix
Input: 26/29 volt D.C., 28 amps. Output: 115 volt, 3 phase, 400 cycle, 250 volt amp., .8 pf. **$59.00**

12147-1 Pioneer
Output: 115 VAC 400 cycles; single phase. Input: 24-30 VDC; 8 amps.
Price $39.50 each

778 Bendix
Output: 115 volt 400 cycle; 190 VA; single phase and 26 volt, 400 cycle, 60 VA, single phase. Input: 24 VDC. **$37.50**

10285 Leland
Output: 115 volts AC; 750 VA, 3 phase, 400 cycle, .90 pf and 26 volts. 50 VA single phase, 400 cycle, .40 pf. Input: 27.5 VDC 60 amps. cont. duty, 6000 rpm. Voltage and frequency regulated. **$59.50**

10339 Leland
Output: 115 volts; 190 VA; single phase; 400 cycle, .90 pf. and 26 volts; 60 VA; 400 cycle, .40 pf. Input: 27.5 volts DC, 18 amps. cont. duty, voltage and freq. regulated. **$49.50**

10486 Leland
Output: 115 VAC; 400 cycles; 3-phase; 175 VA; .80 pf. Input: 27.5 DC; 12.5 amps.; cont. duty. **$70.00**

10563 Leland
Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 pf. Input: 28.5 VAC; 12 amps. **$35.00**

PE109 Leland
Output: 115 VAC, 400 cyc.; single phase; 1.53 amp.; 8000 rpm. Input: 13.5 VDC; 29 amp. **$50.00**

PE218 Leland
Output: 115 VAC; single phase pf. 90; 380/500 cycle; 1500 VA. Input: 25-28 VDC; 92 amps.; 8000 rpms.; Exc. Volts 27.5. BRAND NEW **$30.00**

MG149F Holtzer-Cabot
Output: 26 VAC @ 250 VA; 115 V. @ 500 VA; single phase; 400 cycle. Input: 24 VDC @ 36 amps. **$40.00**

MG153 Holtzer-Cabot
Input: 24 VDC; 52 amps. Output: 115 volts —400 cycles, 3-phase, 750 VA. Voltage and frequency regulated. **$95.00**

DMF2506M Continental Electric
24-30 volts input; 5.5-45 amps.; cont. duty. Output: 115 volts; .44 amps.; 400 cyc.; 1 phase; pf. 1.0; 50 watts. **$39.50**

940702-1 Elcar, Class "A"
Input: 27.5 volts at 9.2 amps. AC. Output: 115 volts 400 cycles; 3 phase 100 voltamp; continuous duty. **Price $39.50 each**

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Model TS-89/AP ratio 10-100
$37.50 each

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1F Syn. Mtr. 115/90V 60 cy.	37.50
1G Gen. 115V 60 cy.	37.50
1SF Syn. Mtr. 115/90V 400 cy.	12.50
2J1F1 Gen. 115/57.5V 400 cy.	7.50
2J1F3 Gen. 115/57.5V 400 cy.	10.00
2J1FA1 Gen. 115/57.5V 400 cy.	7.50
2J1G1 57.5/57.5V 400 cy.	5.00
2J1H1 Diff. Gen. 57 5V 400 cy.	7.50
2J5D1 Cont. Trans. 105/55V 60 cy.	17.50
2J5F1 Cont. Trans. 105/55V 60 cy.	17.50
2J5H1 Gen. 115/105V 60 cy.	17.50
2J15M1 Gen. 115/57.5V 400 cy.	17.50
5CT Cont. Trans. 90/55V 60 cy.	34.50
5D Diff. Mtr. 90/90V 60 cy.	34.50
5DG Diff. Gen. 90/90V 60 cy.	34.50
5F Syn. Mtr. 115/90VAC 60 cy.	34.50
5G Syn. Gen. 115/90VAC 60 cy.	34.50
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C69406-1 Type 11-2 Rep. 115V 60 cy.	20.00
C76166 Volt. Rec. 115V 60 cy.	10.00
C78248 Syn. Transm. 115V 60 cy.	12.50
C78249 Syn. Diff. 115V 60 cy.	5.00
C78863 Repeater 115V 60 cy.	7.50
C79331 Transm. Type 1-4 115V 60 cy.	20.00
851 Bendix Autosyn Mtr. 22V 60 cy.	7.50
403 Kollsman Autosyn. Mtr. 32V 60 cy.	7.50
FPE-25-11 Diehl Servo Mtr. 75/115V 60 cy.	22.50
FPE-43-1 Resolver 400 cy.	25.00
FJE-43-9 Resolver 115V 400 cy.	25.00
999-0411 Kollsman 26V 400 cy.	15.00
13770410 Kollsman 26V 400 cy.	10.00
15158-0410 Kollsman 26V 400 cy.	20.00
10047-2-A Bendix 26V 400 cy.	12.50
2900 Transicoil 115 V 400 cy.	15.00

SIMPLE DIFFERENTIAL

Size: 2-5/32" long x 1¼" dia.; bearing one end ½" O.D.; Shaft Size: 1" long, threads 8-32-⅜" long, with bearing shaft ⅛" dia. x ¼" long. Gear on shaft end 1-7/16" dia., gear on bearing end 1¼" dia. Drive gear 25/32" dia.

Stock No. 101

$3.95 ea.

SIMPLE DIFFERENTIAL

1:1 reverse ratio, 60 teeth on large gear; ¼" shaft. Size: 3" long with 1-15/16" dia.

Stock No. 108

$3.95 ea.

SIMPLE DIFFERENTIAL

size 2-$\frac{11}{16}$" long, 1-$\frac{11}{16}$" diameter, ¼" shaft each end 1-1 reverse ratio 32 teeth on input and output gear price.....**$3.50 each**

stock no. 149

Dual Simple Differential

1:1 reverse ratio on both. Size: 3¼" long x 1-7/16" dia. Shaft size: ⅛" and 5/32".

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$7.50 ea.

SMALL DC MOTORS

(approx. size overall 3¾" x 1¼" dia.)

5069600 Delco PM 27.5 VDC 250 rpm	12.50
50669230 Delco PM 27.5 VDC 145 rpm.	15.00
5068750 Delco 27.5 VDC 160 rpm w/brake	6.50
5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2")	5.00
5069625 Delco 27.5 VDC 120 rpm w/governor	15.00
5BA10AJ18 GE 24 VDC 110 rpm	10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible	10.00
5BA10AJ52 27 VDC 145 rpm reversible	12.50
5BA10AJ50, G.E., 12 VDC, 140 R.P.M., reversible	15.00
5BA10FJ32, G.E., 12 VDC, 9.5 R.P.M., reversible	15.00
5BA10FJ33, G.E., 12 VDC, 56 R.P.M. reversible	15.00
806069 Oster series reversible 1/50 h.p. 10,000 rpm 27.5 VDC 1⅛" x 3½"	5.00
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7100-B-PM Hansen 24 VDC 160 rpm	7.50
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2K54 ..... 5.00	EL-C6J 12.00	250TL 12.50	815 ..... 1.00	5734 ..... 12.50
2K55 ..... 5.00	EL-C6L 5.00	WE-251A 50.00	816 ..... 1.10	5740 ..... 35.00
2V3G 1.25	EL-6C/4825 ..... 8.00	WE-252A 7.50	826 ..... .50	5750 ..... 2.50
2X2 ..... .25	6AC7W 1.00	WE-253A 2.50	828 ..... 8.00	5763 ..... 1.25
2X2A ..... .90	6AD4 ..... 2.50	WE-254A 2.75	829 ..... 4.00	5771 ..... 275.00
3A4 ..... .50	WE-6AK5 ..... 1.25	WE-257A 2.00	829B 8.50	5798 ..... 8.50
3A5 ..... .60	6AK5W 1.00	FG-258A 80.00	830B ..... .50	5800 ..... 7.50
3AP1 ..... 2.00	6AL5W ..... .75	WE-262B 5.00	832 ..... 2.50	5801 ..... 5.00
3AP11A 5.00	6AN5 ..... 2.25	267B 5.00	832A 5.00	5803 ..... 6.00
3B21 ..... 3.50	6AR6 ..... 1.25	WE-268A 5.00	833A 30.00	5827 ..... 5.00
3B24 ..... 1.00	6AR6WA 2.50	FG-271 ..... 40.00	834 ..... 7.50	5828 ..... 6.50
3B24W 4.85	6AS6 ..... 1.25	WE-271A 6.50	836 ..... 1.25	CK-5829 ..... 1.00
3B24WA 8.50	6AS6W 2.25	WE-274B ..... .90	837 ..... 1.00	5842 ..... 12.50
3B25 ..... 4.50	6AS7G 3.00	WE-276A 7.50	838 ..... 1.00	5847 ..... 12.50
3B26 ..... 3.00	6BA5 ..... 2.50	WE-282A 3.50	842 ..... 1.50	5915 ..... .75
3B27 ..... 2.50	6C21 ..... 15.00	WE-283A 3.50	845 ..... 3.50	5932 ..... 3.75
3B28 ..... 4.50	6J4 ..... 1.75	WE-285A 5.00	849 ..... 17.50	5933 ..... 2.00
3B29 ..... 4.50	6J4WA 2.50	WE-286A 3.50	850 ..... 15.00	5948/1754 ..... 225.00
3BP1 ..... 1.50	6J6W 1.00	287A 2.50	851 ..... 7.50	5949/1907 ..... 75.00
EL-3C 5.00	6L4 ..... 3.50	WE-300B 5.00	860 ..... 2.50	5962/BS-101 ..... 5.00
EL-3CJ 8.50	6K4A 3.10	304TH 8.50	866A 1.25	5963 ..... 1.40
3C22 ..... 50.00	6L6WGA 3.75	304TL 12.50	866JR 1.00	5977 ..... 3.50
3C23 ..... 3.75	6SK7W 1.00	307A ..... .50	869B 50.00	5979/BS-1 ..... 10.00
3C24 ..... 2.50	6SN7W 1.50	WE-310A 4.00	872A 1.35	5980/BS-2 ..... 8.50
3C33 ..... 7.50	6SK7WA 2.00	WE-313C 3.00	884 ..... .95	5981/5650 ..... 75.00
3C45 ..... 6.00	6SU7GTY 2.50	316A ..... .50	885 ..... .95	5998 ..... 5.00
3D22 ..... 7.50	6X4WA 2.00	WE-323A 10.00	902A/P1 ..... 2.00	6098 ..... 2.50
3DP1 ..... 3.00	6X5W 1.25	323B 6.00	913 ..... 17.50	8002R 15.00
3DP1A 5.00	7BP7A 7.00	WE-328A 3.50	917 ..... 1.50	8005 ..... 4.50
3E29 ..... 8.50	7CP1 ..... 5.00	WE-337A 6.00	918 ..... 1.50	8012A 3.50
3EP1 ..... 1.50	7EP4 ..... 10.00	WE-339A 7.50	922 ..... 1.75	8013 ..... 2.50
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3FP7A 2.50	7HP7 ..... 10.00	WE-350A 2.50	927 ..... .75	8020 ..... 1.50
3GP1 ..... 1.85	10KP7 ..... 25.00	WE-350B 2.00	931A 3.50	8025 ..... 1.00
3GP1A 10.00	12AP7 ..... 50.00	WE-352A 15.00	SN-947C 6.50	9001 ..... .85
3HP7 ..... 3.00	12DP7 ..... 15.00	WE-355A 12.50	SN-948B 6.50	9002 ..... .50
3HP14 ..... 2.50	12DP7A 35.00	WE-356B 3.50	958A ..... .35	9003 ..... 1.25
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Mfd.	Volts	Price
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.005	15KV	29.95
.005	30KV	29.95
.01	1500	.65
.012	25KV	12.95
.015	15KV	14.50
.02	4000	4.75
.02	10KV	5.95
.02	30KV	10.95
.025	50KV	32.95
.03	10KV	7.95
.05	15KV	6.95
.05	25KV	14.95
.06	4.7KV	4.95
.06	7000	14.50
.05	28KV	9.95
.05-.06	15KV	8.95
.08	15 & 6KV	8.95
.1	1250	.29
.1	1500	.35
.1	2000	.59
.1	2500	.79
.1	3000	.95
.1	4000	1.19
.1	5000	1.49
.1	6000	1.79
.1	6000	2.25
.1	7500	.85
.1	7500	4.25
.1	10KV	8.25
.1	12KV	9.95
.1	12KV	12.50
.1	15 & 6KV	12.50
.1	20KV	19.50
.1	25KV	24.50
.1	28KV	37.50
.125	7.5KV	.89
2X.1	2000V	2.25
2X.1	6000	2.50
.2	10KV	8.50
.2	15KV	18.50
.2	20KV	24.50
.2	25KV	29.50
.2	30KV	37.50
3X .2	4000V	2.85
.25	1500V	1.49
.25	2000V	1.98
.25	3000V	3.45
.25	4000V	5.98
.25	6000	.85
.25	15KV	18.95
.25	20KV	19.95
.25	25KV	49.00
.3	2000	.49
2X.33	2000	1.19
.4	10KV	18.50
2X.4	7000	5.29
.5	600	.39
.5	1500	.59
.5	2000	1.19
.5	2500	1.49
.5	3000	1.98
.5	6000	3.95
.5	7500	4.95
.5	25KV	43.95
.5-.1	3000	.89
2X.5	600	.69
2X.5	9000	9.28
1	600	.59
1	1000	.69
1	1500	.89
1	2000	1.49
1	3000	2.25
1	3500	2.98
1	4000	6.25
1	5000	6.50
1	6000	8.95
1	7500	14.50
1	10KV	15.50
1	10KV	30.50
1	14KV	32.50
1	20KV	51.50
1	25KV	71.00
1	30KV	PUR

TYPE "J" POTS $.89

Ohms	Ohms	Ohms
50 L †	10 000 L † *	250 000 L † *
100 L †	15 000 L † *	500 000 L †
200 †	25 000 L † *	600 000 †
500 †	35 000 L † *	1 Meg L † *
1000 L †*	50 000 L † *	1.5 Meg †
2000 † Switch	75 000 † *	2 Meg L †
1500 †	100 000 L † *	2.2 Meg L †
2000 L †	150 000 † *	2.5 Meg †
2500 † *	200 000 L †	4 Meg †
5000 L † *	200 000 L †	

L—Locking Shaft *—1/8SD †—3/8" Shaft Plus

TYPE "JJ" POT $1.60

Ohms	Ohms	Ohms
1500 †	100 000 †	500 000 †
15 000†	150 000 †	750-75 K †
50 000†	250 000†	1 Meg †
75-750 K †		4 Meg †

BATHTUB CONDENSERS

Mfd.	Volts	Price	Mfd.	Volts	Price	Mfd.	Volts	Price
.01	600	.23	3x.1	400	.12	.5	1000	.57
2x.01	600	.25	3x.1	600	.33	2x.5	500	.49
2x.02	600	.25	.2	1000	.19	2x.5	1000	.88
2x.04	600	.25	.25	600	.25	1	100	.23
.05	600	.25	.25	600	.29	1	400	.39
.05	1000	.34	.25	1000	.39	1	600	.45
2x.08	600	.22	2x.25	600	.33	1x1	600	.69
.1	600	.25	2x.25	1000	.43	1x1	230AC	.15
.1	1000	.34	.3	600	.28			
.1	1200	.38	.35	600	.22	2	400	.42
2x.1	600	.19	.5	600	.13	2	600	.65
			.5	600	.35	4	100	.49

CHANNEL CONDENSERS

Mfd.	Volts	Price	Mfd.	Volts	Price	Mfd.	Volts	Price
.01	1000	.27				.5	1000	.35
.025	600	.19	3x.1	400	.19	2x.5	600	.29
.05	400	.15				2x.5	600	.39
.05	600	.19	3x.1	600	.23			
.05	1600	.29	3x.1	1000	.39	5-.1	600	.14
2x.05	600	.29	.25	400	.19	1	250	.10
.1	500	.23	.25	600	.25			
.1	600	.25				1	400	.25
.1	1000	.28	.4	600	.12	1	500	.49
.1	1250	.32	.5	400	.16			
2x.1	400	.21				1	600	.39
2x.1	600	.25	.5	500	.17	2	600	.55
			.5	600	.29			

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OA2	.85	2J32	12.50	3DP1	3.50	C6A	11.00	HK354C	15.00	725A	3.00	902P1	2.75
OA3	.90	2J33	12.00	3DP1A	1.95	7BP7	5.00	357A	15.00	726A	6.00	931A	2.50
OB2	.75	2J34	14.25	3EP1	8.50	7DP7	9.00	368AS	2.00	726B	20.00	954	.35
OB3	.85	2J36	25.00	3EP9	8.50	12AP4	50.00	371B	.90	726C	20.00	955	.35
OC3	.75	2J38	8.95	3GP1	5.00	12DP7A	45.00	385A	4.50	730A	7.50	956	.35
OD3	.75	2J39	8.50	3J21	75.00	LM15	200.00	388A	1.00	750TL	50.00	957	.35
O1B	1.40	2J40	25.00	4B26	5.40			393A	4.50	801A	.50	958A	.35
1B22	1.50	2J42	40.00	4C27	18.00	15E	1.50	394A	2.50	802	2.25	959	2.25
1B23	6.95	2J49	40.00	4C28	23.00	15R	.50	MX408U	.50	803	2.00	E1148	.25
1B34	12.00	2J50	55.00	4E27	8.50	NE16	.50	417A	2.75	805	1.00	1206	.95
1B24A	15.00	2J55	55.00	4J25	50.00	204	.75	434A	15.00	807	1.20	1500T	135.00
1B26	1.25	2J56	110.00	4J26	50.00	KY21A	8.25	446A	.75	808	1.00	HK1554	75.00
1B27	10.00	2J61	20.00	4J27	50.00	RK21	2.50	446B	3.95	809	2.25	1603	4.25
1B38	35.00	2J62A	35.00	4J28	50.00	RX21	8.00	450TH	47.50	810	10.50	1612	1.50
1B50	23.00	2J62	15.00	4J29	50.00	KH24G	1.50	450TL	47.50	811A	3.75	1615	1.25
1B51	7.50	2K22	14.50	4J30	50.00	25T	2.95	464A	2.65	812A	3.95	1616	.50
1B56	35.00	2K23	17.00	4J31	150.00	RK72	.60	471A	4.00	812A	3.95	1619	.50
1B60	35.00	2K25	12.00	4J32	150.00	RK73	.60	527	18.00	813	10.95	1622	1.75
1B21	.50	2K26	44.00	4J33	150.00	FG95	21.00	WL530	4.00	814	2.00	1624	1.25
1N21A	.95	2K28	25.00	4J34	300.00	100TH	6.50	WL531	4.00	815	1.50	1625	.30
1N21B	1.25	2K29	28.00	4J35	150.00	FG105	11.00	WL532	15.00	816	1.50	1626	.30
1N21C	12.50	2K33A	125.00	4J36	150.00	122A	1.75	HK654	35.00	829	6.00	2050T	150.00
1N23	.50	2K39	140.00	4J37	75.00	203A	2.50	700A/D	10.00	829A	7.00	2050	1.00
1N23	.50	2K41	95.00	4J38	150.00	211	.50	701A	2.75	829B	8.00	2051	.65
1N23A	.50	2K42	180.00	4J39	150.00	217C	2.00	703A	1.10	830B	.75	5820	475.00
1N23B	1.50	2K43	110.00	4J40	150.00	242C	18.50	704A	.75	832A	6.00	5826	450.00
1N23C	7.50	2K44	195.00	4J41	150.00	244C	9.50	705A	.75	833A	16.00	8012	1.00
1N25	4.50	2K45	35.00	4J42	150.00	249C	2.50	706AY/		834	7.50	8012A	2.50
1N26	4.00	2K48	75.00	4J51	100.00	250TH	23.00	FY	25.00	836	1.50	8013	1.00
1N27	3.50	2K50	295.00	4J52	225.00	250TL	14.00	707A	3.50	837	1.25	8013A	1.95
1N34A	.50	2K54	35.00	4J53	225.00	252A	3.00	707B	4.00	838	.70	8019	1.75
1N45	2.25	2K55	15.00	5BP1	5.95	274B	2.00	716AY	35.00	849	35.00	8020	2.00
1P25	65.00	2K56	72.00	5BP2A	12.00	304TH	8.75	715A	1.75	857B	125.00	8025	1.50
2C39	7.50	3AP1A	10.00	5BP4	3.95	304TL	10.50	715B	3.00	860	2.00	PD486	95.00
2C39A	9.00	3BP1	7.20	5CP1	1.75	307A	.60	715C	12.00	861	25.00	9001	.85
2C40	9.50	3BP24	1.50	5CP7	5.00	310A	4.50	717A	.35	866A	1.25	9002	.65
2C43	8.50	3BP25	5.00	5CP7A	18.00	310B	4.95	719A	13.00	869B	67.00	9003	1.35
2C44	.50	3BP26	5.00	5CP12	5.00	311A	2.50	720AY/		869BX	50.00	9004	.85
2C46	6.00	3BP28	5.00	5D21	7.95	312A	2.95	GY	50.00	872A	1.25	9005	2.75
2IA	12.00	KL3C	5.50	5JP1	27.50	325A	15.00	721A	.75	874	.60	9006	.20
2J22	4.50	3C22	59.00	5JP2	6.00	327A	3.50	721B	7.25	878	.50		
2J26	15.00	3C24	1.75	5JP4	11.00	325A	6.75	723A/B	7.85	879	.50		
2J27	4.50	3C31	1.40	5LP11A	25.00	350A	2.75	724A	.75	884	1.00		
2J31	14.25					350B	2.75	724B	.75	885	1.00		

Special! TS45 X BAND GENERATOR—$99.00

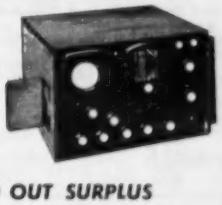
NEW UNUSED SURPLUS TS 259 K BAND

23400-24500 MEGACYCLES SIGNAL GENERATOR

SPECIAL! 5,000 V. POWER SUPPLY $9.90

For IP25 Infrared Image Converter from 3 V. Battery Source. NEW, Complete with RCA 1654 Tube

NEW MICROWAVE TEST EQUIPMENT TS148/UP SPECTRUM ANALYZER TS147D SIGNAL GENERATOR



Field Type X Band Spectrum Analyzer. Band 8430-9580 Megacycles.
Will Check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q or resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.

OTHER TEST EQUIPMENT USED CHECKED OUT SURPLUS

TSKI/SE	T35/AP	TS188	TS226	SURPLUS EQUIP.
TS1A/AP	TS36/AP	TS5110/AP	TS239A-TS239C	APA16
RF4/AP	1-96A	TS125/AP	TS251	APA38
TS12/AP	T8-45	TS126/AP	TS258	APS1 APS4
TS13/AP	TS47/APR	TS147	TS270	APR4
TS14/AP	TS69/AP	TS174/AP	TS418	APR5A
TS33/AP	TS100	TS175/AP	TF890/1	APT2-APT5
TS34/AP	TS102A/AP	TS182	834	

SPECIAL

Available Large quantities at special prices

2AP1	6H6	307A	5691
4C27	6K4G	274A	5692
4C28	6AR6	274B	5693
5A6	5R4WGY	262B	5839
5BP4	5W4GT	328A	5814
4J52	OZ4A	357A	9001
2A4G	OF4A	450TH	9002
6C21	6AC7	450TL	9003
6J5GT	28D7	957	9006
	VT52		
	89		

WHOLESALE and EXPORT ONLY

LIBERTY ELECTRONICS, INC.

Phone: ORegon 4-7070

119 PRINCE ST.
NEW YORK 12, N. Y.
Cable: TELESERUP

Used equipment for sale

6—Model P4 Synchroscopes.

3—Motor Generator sets; Voltage 220Ac; phase 3; Amps 7.5; Frequency 60 cycles; RPM 3600 Voltage 115 adj; Frequency 420 cycles; load amps 10.3; Phase 1; KVA 2; RPM 3600.

POTTER RADIO CO.
1314 McGee St. Kansas City 6, Mo.

BC-610-E, F, H APR-4
BC-221, BC-342, ART-13

ALLTRONICS
Box 19, Boston 1, Mass. Richmond 2-0048

"TAB" THAT'S A BUY

NEW "TABLITE" ELECTRONIC PHOTOFLASH KITS

Portable Units—AC & Battery Inbuilt In One Camera Case

Uses new lo cost lo voltage paper circuit constant bright light output; links duration 1/600 sec'd; color K 6800+; cost per flash less than ½ c; 1000 to 3000 flashes per set of batteries. All kits with inbuilt AC pack. (Kits do not include batteries)

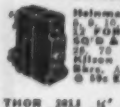
Model 600B, 60W Sec color 75 .=. B&W 225 .=. Recycles 2 sec'd, less than 4 lbs. $20.95
Model 600D, 120W Sec, color 100 .=. B .=. 300 .=. Recycles 4 sec'd, less than 5 lbs. $30.95
Model 1000B, 240W Sec color 150 .=. B&W 450 .=. Recycles 10 sec'd, less than 9 lbs. $44.95
All Above MODELS ASSEMBLED, optional batteries
*Two 2V 240V BATTERIES ..... @ $12
SOLD WITH "TAB" MONEY BACK GTD

PHOTOFLASH & STROBE LAMPS

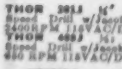
"TAB" No.	Replaces	W-Sec Max	Each
FA1	FA 104/FF1	1100	$0.98
AG-1	AG-1	1100	1.98
FF1	FF, FT 210	1100	1.98
FAV-A	6VLV 4500	1100	3.98
FA2	4500	1100	3.98
FA4	FA 6 / FA100	1100	3.98
FA5	FAX/1500-5500	1100	3.98
2000	TO FT 500	2000	10.95

TRIGGER COIL LO VOLT FLASH $1.67
COND-.025MFD/450VDC/31.5WATT SECONDS
NEW low inductance, compact size .3W; 2"DIA; 6/32 bend 98c for "TAB" Photoflash Data

CIRCUIT BREAKER



Heinemann Mean. Bkrs. Amps: 2, 5, 10, 15, 20, 30 @ $1.98 EACH; 2 FOR $3.75 ..... 50, 60 @ $2.98 EACH; 2 FOR $5.50
50-60 A CH Toggle Bkrs. 4, 10, 15, 20, 25, 30 Amps. 50-60 AC 12/36
Hilcon Thermo Push Button Bkrs. Amps: 4, 10, 15, 20, 25, 30, 35 @ 59c EA; 3/$4; 25 FOR $15



THOR 3013 ¼" Electric Speed Drill w/Jacobs chuck 3400 RPM 110VAC/DC $12.95
THOR 4003 ¼" Electric Speed Drill w/Jacobs chuck 650 RPM 110VAC/DC $27.50

SELSYNS-SYNCHROS

ONE EACH AY1 & AY3 Autosyn use 60 cy 12 to 30 V @ $2.95; 12/$30
AY100-A1 Rotor 60 115V ..... @ $6
AY 201-2A Rotor 1/0 26/Stator 50 11.5V/400cy ..... @ $6
231F1 Gen 115/57.5V/400cy $5.00
231H1 Syn Diff 57.5/57.5V/400cy $5.00
C44606 Syn Motr 115V/60cy $5.00
C56776-1 Syn Motr 115V/60cy $12.50
C56606-1 Syn Motr Type 31-3/115V/60cy $7.50
C57240 Syn Trans 115V/60cy $4.00
C70240 Syn Diff 115V/60cy $4.00

NEW G.E. PHONO CARTRIDGES

Original Boxed—Money Back Gtd

RPX050A .001 A .000 ..... $6.75
RPX051A Gold Treasure $9.25
RPX051A Gold Treasure $9.25
RPX040A Single (S) .000 ..... $ 6.00
RPX041A Single (S) .001 ..... $ 6.00

HI-FI RECORDING TAPE

Sold on Money Back Guarantee

7" REEL, 1200 FOOT Highest Quality Precision Coated & slit, FERRO-SHEEN processed quality controlled, constant output. Noise Free. Plastic tape. Splice Free. Freq. 7½ IPS 40-15 KC Oxide Wnd In. "TAB" SPECIAL @ $1.80 EA; 3 @ $1.50 EA; 12 FOR $1.45 EACH ..... 1000's SOLD

PLANETARY DRIVE

5:1 & 3 to 1 RATIO
Was $5.29 "TAB" @ $3.00 EA; SPECIAL ..... 12 FOR $36

New Xmitting Mica Condenser

.000125MFD/10,000WVDC. CM75, Ceramic cased, "TAB" Special ..... @ $4; 6 FOR $15.

MICROSWITCH

6 S-1, SPNC/30 Amp Cased Hvy Duty Industrial Type Incl. Magnet Suppressor

20¢ Ea; lots of 5
Lots of 100 @ $15

RELAY BARGAINS

Clare SK5010/VAC SLD/DPDT/10-28VDC 3A CTS Octal Base @ $1.50; 12/$15
G.E. MS25306/SPDT/1000 Ohm/6 ma/5A CTS Plug In ..... @ $1.50; 12/$15
GM, 24V/SPNO/20A CTS, dble make @ 79c; 12/$8 B'Dunn 32AXX100/Mount As ..... operated, 115 VAC/10 ma. ..... @ $2.95; 12 FOR $30
Guardian 4000 ohm/SPST/5A cts $1.25; 12/$8
MRM, 115VAC/SPNO/8A ..... 2/$3
B'Dunn 17AXXX100/115VAC/SPNO/30A ..... cts Special @ $3; ..... 6 FOR $12

TRANSFORMER BARGAINS

115V 60CY INPUT

2300V/20MA, 5.2V/6A, 5.2V/1.75A, 4/RC412 Power Replacement ..... @ $6.98; 6 FOR $30
600VCT/200MA, 5V/6A, 6.3VCT/5A @ $3.98; 12/$36

Diamond Replacement Needles

RPJ051D or RPJ051B Single Dia. ..... @ $6.98
RPJ051A Dual Diamond ..... @ $16.98
RPJ051A Dia & Sapphire ..... @ $10.98

REGULATED POWER SUPPLY

LAB or HIFI uses "SOLA" constant voltage Filament & Power Xfmr w/rectifier tubes. Low Resistance Brute force Filter. Furnishes 400VDC @ 250 ma from filter system & 6V/6A 5% regulated & 12V @ 6A filtered DC for filaments. 45 lbs. "TAB" $39.00

NEW "TABTRON" SELENIUM RECTIFIERS

ENGINEERED FOR AUTOMATION & INDUSTRY

"Technical Apparatus Builders" mfgrs. Power Rectifiers to your specs. From one amp up to and above 1000 amps, convention or fan cooled, single or 3 phase. "NEMA" & JAN. Specs.

* FULL WAVE BRIDGE ● DATED & ONE YEAR GTD

Max Amps	18VAC* 14VDC	36VAC* 28VDC	45VAC* 42VDC	72VAC* 64VDC	130VAC* 100VDC	220VAC 217VDC	Ctr Tap AC/DC	3 Phase 120VAC	Bridge 280VDC
½	$1.00	$1.40	$1.70	$2.45	$2.40	$3.00	30/15	$2.50	$3.00
1	1.50	1.80	2.10	2.95	2.90	3.50	60/30	3.00	3.50
2	2.00	2.50	2.90	3.95	3.90	4.50	120/60	4.00	4.50
3	2.50	3.00	3.50	4.95	4.90	5.50	180/90	5.00	5.50
5	3.50	4.00	4.50	6.45	6.40	7.00	300/150	6.50	7.00
10	5.00	6.00	6.50	9.45	9.40	10.00	600/300	9.00	10.00
15	6.50	7.50	8.00	11.45	11.40	12.00	900/450	11.50	12.00
20	8.00	9.00	9.50	13.45	13.40	14.00	1200/600	13.50	14.00
30	11.00	12.00	12.50	17.45	17.40	18.00	1800/900	17.50	18.00
40	14.00	15.00	15.50	21.45	21.40	22.00	2400/1200	21.50	22.00
50	17.00	18.00	18.50	25.45	25.40	26.00	3000/1500	25.50	26.00
60	20.00	21.00	21.50	29.45	29.40	30.00	3600/1800	29.50	30.00
75	24.00	25.00	25.50	34.45	34.40	35.00	4500/2250	34.50	35.00
100	30.00	31.00	31.50	44.45	44.40	45.00	6000/3000	44.50	45.00
150	45.00	46.00	46.50	64.45	64.40	65.00	9000/4500	64.50	65.00
200	60.00	61.00	61.50	84.45	84.40	85.00	12000/6000	84.50	85.00
300	90.00	91.00	91.50	124.45	124.40	125.00	18000/9000	124.50	125.00
400	120.00	121.00	121.50	164.45	164.40	165.00	24000/12000	164.50	165.00
500	150.00	151.00	151.50	204.45	204.40	205.00	30000/15000	204.50	205.00
600	180.00	181.00	181.50	244.45	244.40	245.00	36000/18000	244.50	245.00
800	240.00	241.00	241.50	324.45	324.40	325.00	48000/24000	324.50	325.00
1000	300.00	301.00	301.50	404.45	404.40	405.00	60000/30000	404.50	405.00

RETURN YOUR OLD DUD RECTIFIER—DEDUCT 5% FROM PRICE

Heavy Duty Battery "Fast" Charger Rectifier

12-0-12V (CT) 100 Amp Fan Cooled or 84 Amp Air Cooled. Has'mt 6V Booster Charger.
Model CR15 ..... $14.85
10-0-10V (CT) Fan Cooled for 12V/60A and 6V/100A Booster Chargers.
Model CR20 ..... $18.85
Return Dud Deduct 10%

230 to 115 V Autoformers

For 230v/50cy Input. To 110-115V or Step up. T With Cord, Plug & Receptacle.

TPA050/50 W *	$2.65
TPA075/75W *	3.25
TPA100/100W *	4.00
TPA200/200W *	6.75
TPA350/350W *	9.25
TPA500/500W *	11.50
TPA750/750W *	15.75
Model TPA1000 Watts, 1 Ø *	$18.75
TPA1500/1500W *	$22.50
TPA2000/2KW *	$34

*Less Cord, Plug & Receptacle.

High Current Power Supplies

ONE YEAR GUARANTEE

Variable 0-18VDC, Completely Built, Ready to go. Full Wave Selenium Rectifier, Transformer Varier, 4" Volt & Amp Meters, Switch, Terminals & Fuses. Hvy Duty Steel Cabinet Std 115V/60 cy Input or 230V 1 Ø phase) to order.

Stock NUMBER	Continuous Rating	With Meters
T28V5AF	0-28 VDC at 5 Amp	$80
T28V10ACG	5 Amp (0 % Ripple)	$100
T28V12ACG	6 Amp 0.01 % Ripple	$105
T28V12AF	0-28 VDC at 12 Amp	$120
T28V12ACC	12 Amp (5 % Ripple)	$130
T28V12AGC	12 Amp 0.01 % Ripple	$170
T28V25AF	0-28 VDC at 25 Amp	$220
T28V24ACC†	24 Amp (5 % Ripple)	$210
T28V24AGC†	24 Amp 0.01 % Ripple	$270
T28V50AF	0-28 VDC at 50 Amp	$360
T28V50AACC†	50 Amp (5 % Ripple)	$410
T28V100AF	0-28 VDC at 100 Amp	$610
T28V100AACC†	100 Amp (5 % Ripple)	$710

Variable 75 to 135 VDC Completely Built, Ready to Go. Includes F. W. Selenium Bridge Rectifier, Resistance for Volt & Ammeter.

Specify for 110 or 230 VAC 1 phase, 60 cy Input.

T130V1AC	0-130 V VDC at 1 Amp
T130V5AGC	5 Amp (1 % Ripple)
T130V15AGC	0-130 VDC at 15 Amp
T130V30AGC†	0-130 VDC at 30 Amp (1 % Ripple)

Modified for Variac® Meters

POWER SUPPLIES TO YOUR SPECS. WRITE US YOUR REQUIREMENTS

FILTER CAPACITORS

CE115UM 5000MFD 15V	98c; 3/$1.50; 10/$5
CE130UM 2500MFD 30V	$2.50 EA; 10 for $20
CE135UM 2500MFD 50V	$3.98; 2 for $7

"TABTRAN" Rectifier Chokes

CR14001 / 1 Amp/0.1 HY/1.4 Ohm	$1.98
CR14002 / 2 Amp/0.1 HY/.67 Ohm	2.50
CR14003 / 3 Amp/.07 HY/.4 Ohm	3.50
CR14004/12 Amp/.01 HY/.1 Ohm	6.50
CR14005/24 Amp/.005 HY/.028 Ohm	14.98
CR14006/50 Amp/.001 HY/.008 Ohm	29.98
CR14006/50 Amp/.001 HY/.001 Ohm	62.00

"TABTRAN" Rectifier Xfmrs

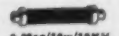
Sec'd Volts (DUAL † 0-9-18-18 & 0-9-18-18 Series Sec'ds 0-3-6-9-12-15-18-21-24-27-30-32-36 Volts	
TR50007 1 Amp†	$5.25
TR50008 2 Amp†	6.25
TR50009 3 Amp†	7.25
TR50010 12 Amp†	16.65
TR50011 24 Amp†*	35.65
TR50064 50 Amp†*	69.50
TR50065 100 Amp†*	100.65
18 Volt 2 Amp	$3.98; 2 for $3.50

*Windings in Series at Ratings shown; Parallel 2X Current, Voltage 0-9-18-18.
*Dual Pri 115 & 220V 60 cy.

SAVE $$$

"TAB" SLASHES PRICES AGAIN ON *Famous Makes Hi-Meg, Hi-Volt, Power and Glass Resistors, Controls, Selsyns & Synchros*

HI-MEG HI-VOLT RESISTORS



.2 Meg/10w/10KV	.50	@ 1	12/$5
.75 Meg/10w/15KV *MVP	.50	@ 1	12/$5
1 Meg/10w/15KV	.50	@ 1	12/$5
2 Meg/4w/6 KV **MVG	.50	@ 1	12/$5
2 Meg/6W/7.5KV *MVT	.50	@ 1	12/$5
2.5 Meg/20w/15 KV *MVA	$1.50	@ 1	12/$15
3 Meg/10w/15KV *MVP	.50	@ 1	12/$5
5 Meg/10w/15KV *MVP	.50	@ 1	12/$5
7 Meg/15w/15KV *MVP	.50	@ 1	12/$5
10 Meg/4w/5KV **MVG	.50	@ 1	12/$5
10 Meg/10w/15KV *MVP	.50	@ 1	12/$5
12 Meg/10w/15KV *MVP	.50	@ 1	12/$5
20 Meg/10w/15KV *MVP	$1.50	@ 1	12/$15
30 Meg/20w/30KV *MVP	$2.50	@ 1	12/$24
40 Meg/25w/40KV *MVC	$2.50	@ 1	12/$24
100 Meg/10w/15KV *MVP	$1.50	@ 1	12/$15

Deduct 10% Disc Qtys 100—May Be Asst'd

POWER RESISTORS Lug Type

Ohms	Watts	Ohms	Watts	Ohms	Watts
.5	10	150	150	7500	10
1	10	250*	150	10K	10
1	25	300	150	15K	10
1	75	500	150	15K	25
1.6	75	750	150	15K	50
2	10	1K	150	15K	75
2	25	1500	25	15K	100
2	50	1500	50	15K	150
2	75	1500	75	15K	200
2	100	1500	100	150K	100

*Adjustable, †Candohm

5 Watts @ 14¢EA; 10w @ 15¢EA; 15w @ 18¢EA; 20w @ 21¢ @ 23¢EA; 30w @ 25¢EA; 50w @ 40¢EA; 100w @ 75w @ 65¢EA; 100w & 150w @ 87¢EA.
10% Disc Qtys 12 or more one value

SPRAGUE GLASS RESISTORS

Ohms	Watts	Ohms	Watts	Ohms	Watts
1.43	25	1500	120	5K	120
25	25	2000	120	5K	25
200	25	2500	25	10K	25
1K	25	2500	120	10K	120
1K	120	5K	25	50K	15

20¢ EACH ANY VALUE
100 of one value @ $15.00

CONTROLS POTENTIOMETERS

Ohms	Watts	Shaft	10 For	100 @
10	4	5/16	$2.10	$15
100	2		2.30	16
250	2	1/2	2.50	17
1K	2		2.70	18
2K	2	3/8	2.90	19
5K	2	1 5/8	3.10	20
10K	2	7/16	3.30	21
25K	4		3.50	22
40K	4	1/2	3.70	23
50K	4		3.90	24
100K	4		4.10	25
200K	2	1/4	4.30	26
250K	2		4.50	27
500K	2	1/2	4.70	28
1Meg	2		4.90	29
2 Meg	2	1 1/2	5.10	32

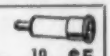
S-Screwdriver

NEW CONDENSER #BT-14

.012 Mfd 5000 WVDC tubular mica, axial stud terminals 13 ½" x 1 ½" Dia. @ $4; 6/$23; 25/$78

NEW HI Q PHONE CW FILTER, USN # 68304 Mfgr UTC ..... AN/ ..... Navy, Ship or Ham use. ..... Reg. "TAB" SPECIAL ..... $2.98; 4/$10

IN23B Crystal Diode



"TAB" SPECIAL IN21 ..... 69¢ ea; 10 FOR $5
6 For $1

STEVENS ARNOLD DC-AC CHOPPER,

0-600 cps Type CH365 SPDT Coil DC 28V/800Ω Imp 60cy/830 ohm, 400 cy/1100 ohms Electro-Mech. Vibrator used as Chopper, rectifier, demodulator, sq. wave generator, Ideal Servo Applications Reg $20 SPECIAL ..... @ $3.75; 4 FOR $12

MICA CONDENSERS

MFD	WVDC	Price
.08	600	45c; 100/$35
.01	1000	38c; 100/$29
.001	1300	29c; 100/$16
.002	1300	35c; 100/$30
.018	1500	35c; 100/$30
.005	2500	45c; 100/$36

PRECISION RESISTORS

1% ACCURACY GTD
SPECIAL 10c EA
10 OF ONE VALUE 10c ea
100 OF One Value $6.98
100 Asst'd Values $10.00
WRITE FOR FULL LISTING

New Diehl Miniature PM Motor

Hi efficiency, ball bearing, type FD6-21, RPM 10,000/27.5VDC, operates on 12 to 27.5VDC. Excel for Models, RR & experimenters. 1" R x 1" W x 2" D. 830 Reg. "TAB" SPECIAL @ $1.95 EA; 12 FOR $15

TUBES

"TAB" TESTED *INSPECTED* GUARANTEED!!!

0A2	$ .74	3C45	7.00	304A	1.85	1201	.75	5810	32.00
0A3	.80	3D21A	2.95	414A	2.75	1612	1.25	5820	45.00
0B2	.80	3E29	12.00	446A	2.75	1616	.50	5840	7.50
0C3/VR90	.64	3K22	125.00	446B	3.00	1619	.50	5841	7.50
0C3/VR105	.74	3K2500A	100.00	450TH	65.00	1620	.50	5842	11.00
0C3/VR150	.74	4-65A	4.00	707A	3.00	1621	.50	5847	3.50
1A3	.64	4-125A	10.00	811DX	1.95	1625	.50	5851	3.50
1AG4	1.25	4D21	6.00	811AX	1.85	1629	.50	5875	1.50
1AH2	1.25	4E27	6.00	811ADX	2.00	1630	.50	5879	1.50
1B3	.65	4C35	15.00	811DDX	2.00	1632	.50	5910	.75
1B22	1.25	4J52	50.00	5514DX	2.50	1633	.50	5932	3.95
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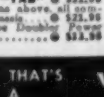

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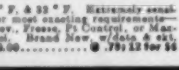

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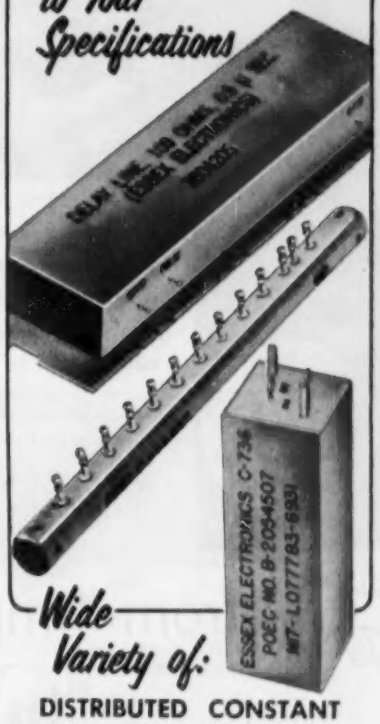

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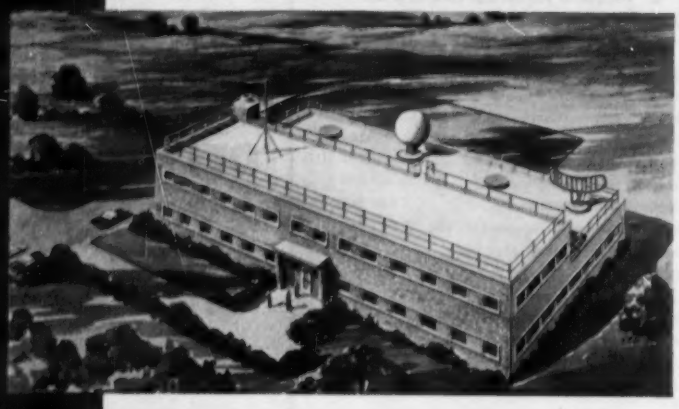

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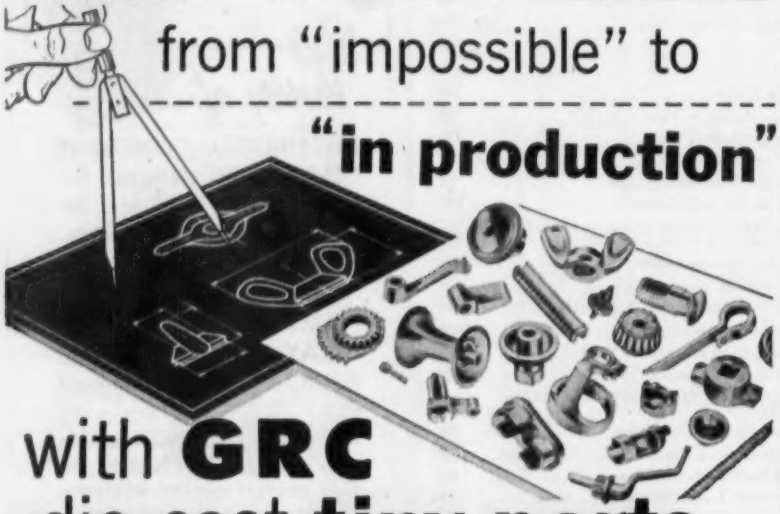

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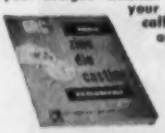

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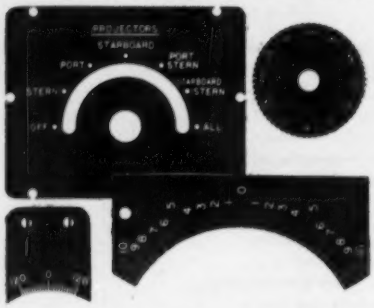

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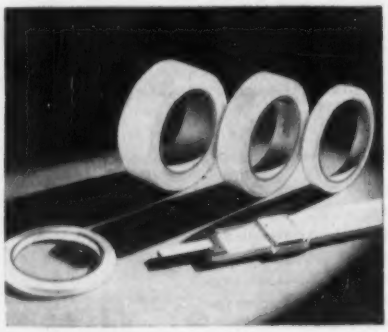

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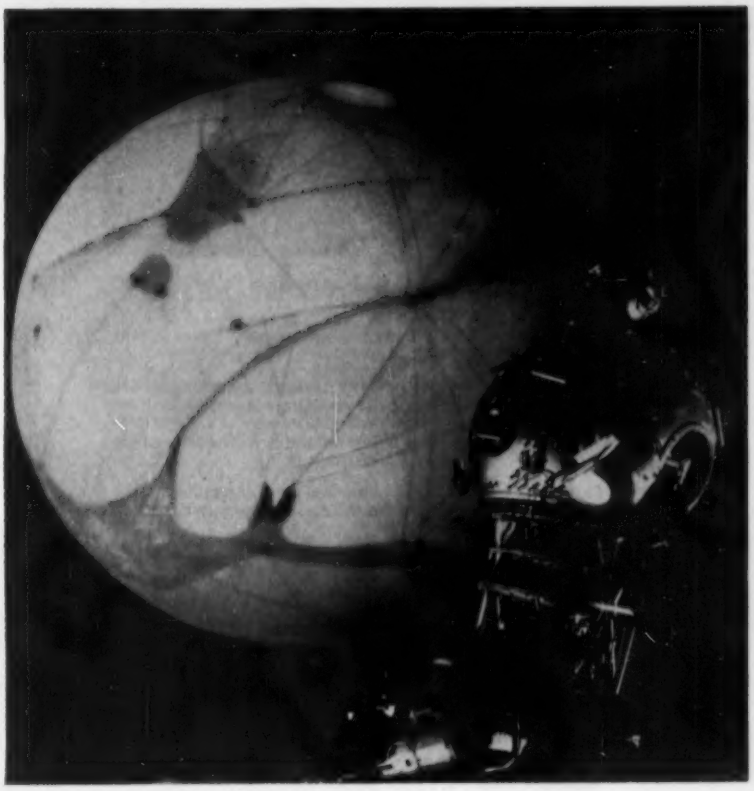

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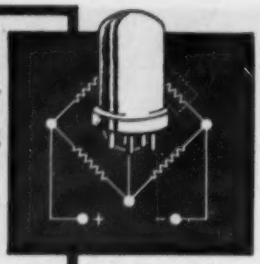

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In the bridge shown assume the dotted resistor to be a resistance temperature detector and the other resistors adjusted so that the bridge will reverse current flow through the relay at a given temperature. The polarized relay will sense the reverse current flow to close (or open) its contacts at the null point.

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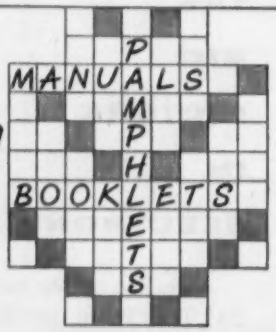

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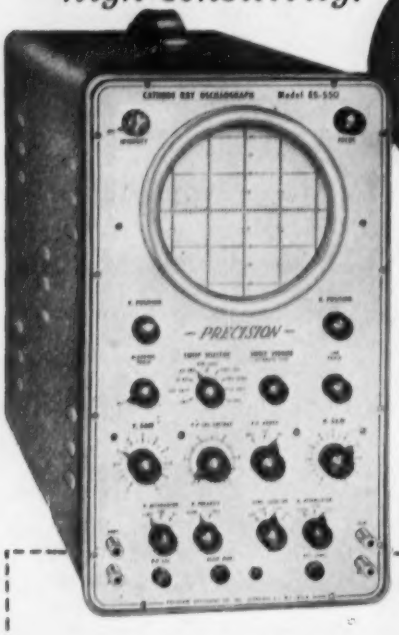

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35	59	78	96D	121	196	218	243	268	292	316	343	365	387	403LB	411RB	419LB	429B		

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LITERATURE? USE SECTION C

SECTION C CIRCLE FOR LITERATURE HERE!

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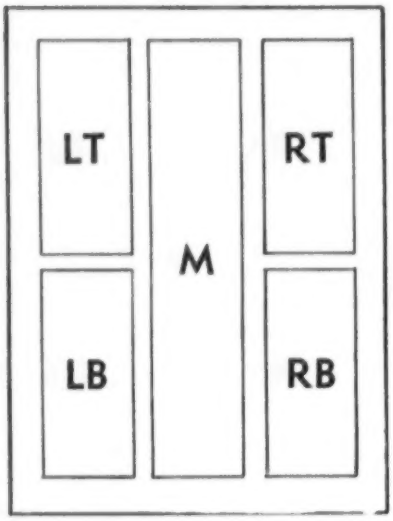
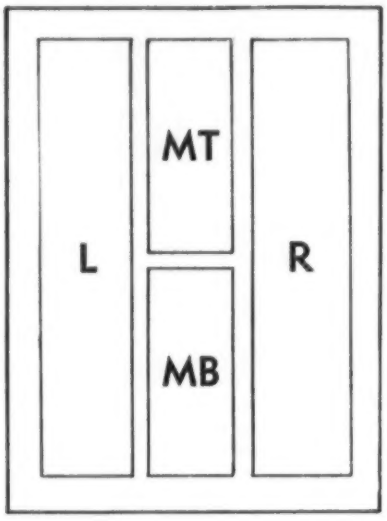
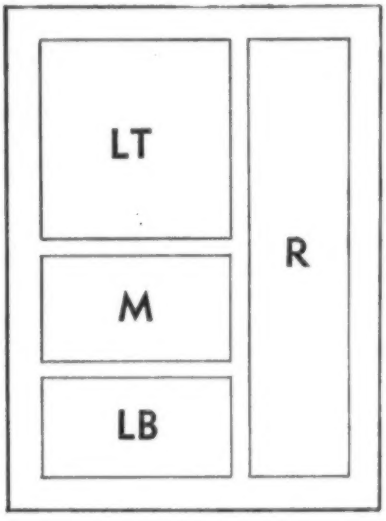
DIAGRAMS BELOW SHOW HOW TO USE THE KEY

ON PAGES WITH MORE THAN ONE ADVERTISEMENT







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RT—Right Top

RB—Right Bottom

L—Left

LT—Left Top

LB—Left Bottom

M—Middle

MT—Middle Top

MB—Middle Bottom

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• Please Print Carefully •

NOV 1956
CARD EXPIRES
FEB • 1ST

• electronics • READER SERVICE CARD
Please Print Carefully

NAME POSITION

COMPANY

ADDRESS

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SECTION B — CIRCLE FOR NEW PRODUCTS HERE!

P1	P6	P11	P16	P21	P26	P31	P36	P41	P46	P51	P56	P61	P66	P71	P76	P81	P86	P91	P96
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P3	P8	P13	P18	P23	P28	P33	P38	P43	P48	P53	P58	P63	P68	P73	P78	P83	P88	P93	P98
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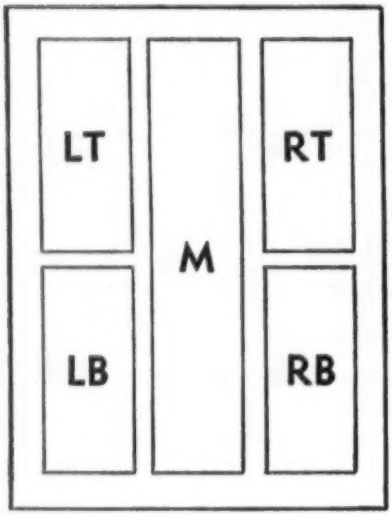
P5	P10	P15	P20	P25	P30	P35	P40	P45	P50	P55	P60	P65	P70	P75	P80	P85	P90	P95	P100

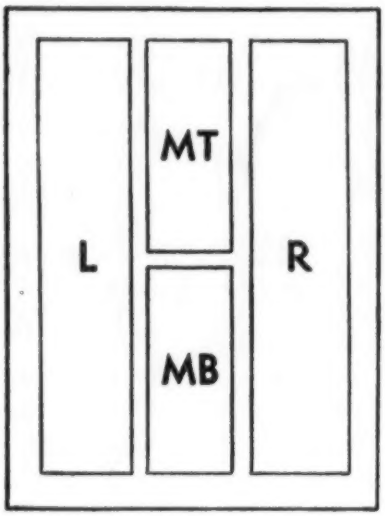
LITERATURE? USE SECTION C

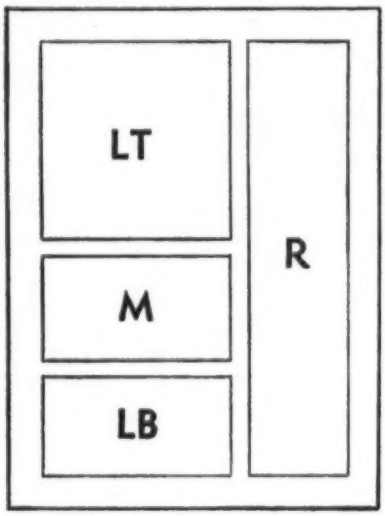
SECTION C — CIRCLE FOR LITERATURE HERE!

L1	L6	L11	L16	L21	L26	L31	L36	L41	L46	L51	L56	L61	L66	L71	L76	L81	L86	L91	L96
L2	L7	L12	L17	L22	L27	L32	L37	L42	L47	L52	L57	L62	L67	L72	L77	L82	L87	L92	L97
L3	L8	L13	L18	L23	L28	L33	L38	L43	L48	L53	L58	L63	L68	L73	L78	L83	L88	L93	L98
L4	L9	L14	L19	L24	L29	L34	L39	L44	L49	L54	L59	L64	L69	L74	L79	L84	L89	L94	L99
L5	L10	L15	L20	L25	L30	L35	L40	L45	L50	L55	L60	L65	L70	L75	L80	L85	L90	L95	L100

DIAGRAMS BELOW SHOW HOW TO USE THE KEY
ON PAGES WITH MORE THAN ONE ADVERTISEMENT







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Reader Service Dept.
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On pages with more than one advertisement, the page number PLUS the correct letters (as shown above) are necessary to indicate the POSITION of the advertisement.

You must circle the page number with the correct letters after it (i.e. 240 L, which means page 240 Left).

USE THIS KEY:

R—Right

RT—Right Top

RB—Right Bottom

L—Left

LT—Left Top

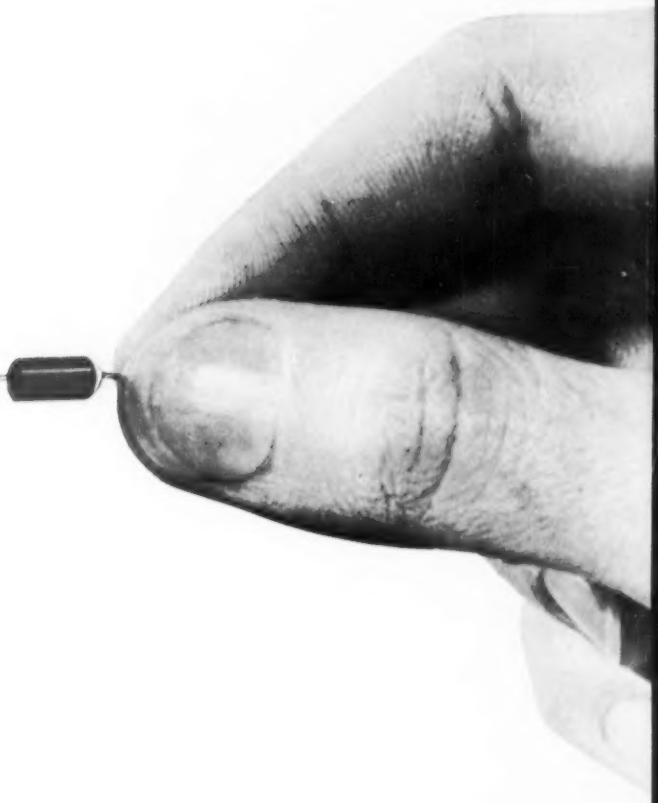
LB—Left Bottom

M—Middle

MT—Middle Top

MB—Middle Bottom

how large is small?



DAVEN'S NEW MINIATURE WIRE WOUND RESISTORS PROVIDE AS MUCH AS 400K RESISTANCE IN $\frac{1}{4}$" x $\frac{5}{16}$" SPACE

DAVEN's fully encapsulated, miniature, precision wire wound resistors offer the design and development engineer the solution to critical space limitation problems. DAVEN's advanced techniques provide the needed resistance value in a minimum of space, without sacrificing reliability. Where space conservation is a prime factor in your design, specify DAVEN miniature wire wounds.

Types and Specifications

Type	Dia.	Length	Max. Ohms	Max. Watts
1274	3/16	3/8	100K	0.25
1273	1/4	5/16	400K	0.25
1283	1/4	5/16	400K	0.25
1284	1/4	27/64	.5 Meg.	0.25
1250	1/4	1/2	900K	0.33
1170A	7/16	1/2	1.2 Meg.	0.50
1170	1/2	1/2	1.8 Meg.	0.50

• Fully encapsulated • Meet and exceed all humidity, salt water immersion and cycling tests as specified in MIL-R-93A, Amendment 3 • Operate at 125°C continuous power without de-rating • Can be obtained in tolerances as close as ±0.02% • Standard temperature coefficient is ±20PPM/°C.

THE DAVEN CO.

526 West Mt. Pleasant Ave.
Route 10, Livingston, N. J.

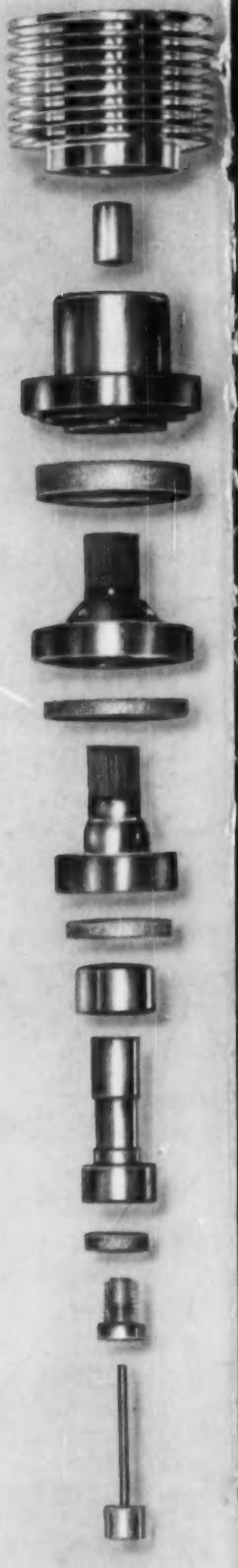
Special temperature coefficients can be supplied on request.

Write for our new resistor catalog.

Ceramic bushings—important design feature of

NEW UHF BEAM POWER TUBES

RCA-6816 and RCA-6884



Actual size exploded view of these new UHF Beam Power Tubes. Seen are the coaxial structure, the one-piece construction of elements and the unique control and screen grids.

lightweight...small size...high efficiency

80 watts cw output at 400 Mc! • 40 watts cw output at 1200 Mc!

Only 1⅞" high, 1¼" diameter, and 2-ounces in weight, RCA-6816 and RCA-6884 are exceptionally well suited for oscillator, multiplier, and amplifier applications in communications equipment where *light weight, physical compactness, and rugged construction* are important design considerations.

These versatile RCA-designed tubes are the result of unusual precision-production techniques and processes. For example, simultaneous cutting of both control grid and screen grid is effected by an electrical-discharge method which assures exceptionally uniform and accurate alignment of these structures. All welding of tube elements to their individual supports and internal leads is eliminated through use of one-piece construction which combines each electrode, its support, and its external contact surface. This feature provides low-inductance paths, high electrical and thermal conductivity, and rugged construction. Coaxial electrode structure, and low-inductance large-area rf electrode terminals *insulated from each other by low-loss ceramic bushings* facilitate the use of these tubes in circuits of the coaxial-cylinder cavity type. Both types have integral radiator and gold-plated contact surfaces.

Because of their high power sensitivity and high efficiency, these new RCA tubes can be operated with relatively low plate voltage to give large power output with small driving power. RCA-6816 has 6.3-volt, 2.1-ampere heater and RCA-6884 has 26.5-volt, 0.52-ampere heater.

Typical CCS Values for RCA-6816 and RCA-6884 in CW Service

	400 Mc	1200 Mc
DC Plate Volts	900	900
DC Plate Amperes	0.170	0.170
Useful Power Output (watts)	80	40
Power Gain	29	9

Investigate these two new types for your uhf equipment designs. For sales information, contact the RCA District Office nearest you:

EAST: HUmboldt 5-3900
744 Broad Street
Newark 2, N. J.

MIDWEST: WHitehall 4-2900
Suite 1181,
Merchandise Mart Plaza
Chicago 54, Ill.

WEST: RAymond 3-8361
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For technical bulletin now in production, write RCA, Commercial Engineering, Section K19Q Harrison, N. J.

RADIO CORPORATION OF AMERICA
Tube Division Harrison, N. J.